PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

VOL. IV

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PROCEEDINGS

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CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

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I.

REPORT OF THE PRESIDENT OF THE ACADEMY FOR THE YEAR 1913.

MEMBERSHIP

The Academy now has a membership of 491. Of these 375 are Resident Members, 84 are Life Members, and 32 are Honorary Members.

During the year, 144 new members were elected and qualified. By resignation the Academy lost 11 members, and by death the following eight:

R. M. Brereton, Woodstock, Oregon	Life Member
Hon. John P. Jones	Life Member
Henry C. Schaertzer, San Francisco	Resident Member
Herbert Brown, Tucson, Arizona	Resident Member
Andrew B. McCreery	Life Member
Dr. Wm. McMichael Woodworth, Cambridge, Mass.	Life Member
Col. A. G. Hawes, San Francisco	Life Member
Gen. L. H. Foote, San Francisco	Life Member, and for many years an officer of the Academy

QUARTERS AND MEETINGS

The Academy is still housed in temporary quarters at 343 Sansome Street. It has held regular bimonthly meetings, and a good attendance at these meetings may be accepted as evi-

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dence of active interest in the Academy's affairs by its members.

As the business affairs of the Academy are in the hands of its Trustees, these stated meetings should be devoted primarily to the discussion of scientific subjects. This has been the case only to a limited extent since the Academy has been housed in temporary quarters. The time has now come when there should be a resumption of the old practice of giving those who are actively engaged in scientific work, whether within the Academy or without, frequent opportunity of presenting the results of their work in a more or less informal way to those who are interested. Some steps toward encouraging the use of the stated meetings for this purpose have already been taken; but the afternoon meetings are ill adapted for this purpose, and it is believed that it will be wise to return at an early day to the old practice of meeting in the evening.

The Academy has been accumulating a large amount of material in its temporary quarters. Most of this is for reference and study. At the present time the collection, together with the library, which has also assumed fair proportions, taxes the available floor-space nearly to its limit. The need of permanent and large quarters, and the need of a place in which exhibits for the benefit of the public may be installed, has been an ever-increasing one.

THE NEW MUSEUM BUILDING

The Academy was granted, by a vote of the people of San Francisco on November 15th, 1910, the right to erect a museum building in Golden Gate Park. Preparations to avail ourselves of this privilege have been under way for several years. The plans for a building have been finally accepted by the Academy, and have been approved by the Park Commissioners. Contracts have been awarded for the grading, the brick and concrete work, and the stone work required for the erection of the first unit of the proposed building. This first unit, consisting of a section of the main front of the building with two wings, of which one is to be used for research work, will cost about $164,000.

Some evidence of the esteem in which the Academy is locally held may be found in the fact that the Building Committee of the Board of Supervisors of San Francisco declared its willingness to recommend that the Academy be granted the right to erect its museum building at the Civic Center, provided that satisfactory assurance could be given that our building would be completed in a reasonable number of years. Owing to the fact that our financial situation did not justify the giving of such an assurance, covering a possible total expenditure of from $600,000 to $800,000, this proposition could not be entertained, and the matter had to be dropped.

RESOURCES

The property of the Academy stands upon the books at a value of about $1,300,000, subject to an indebtedness of $300,000. The details of this book-value and of the annual income appear in the Treasurer's report.

It is interesting to note that the net annual income from the Academy's property on Market Street (the Commercial Building) is about $46,700, and that from other sources, such as fees and dues, interest on special funds and short term loans, this income is swelled to about $53,700.

The Academy has expended during the last year for rent, salaries, and on its collections, about $32,700. The funds available for building have been increased by about $21,000.

It is estimated that a sum of from $125,000 to $130,000 can be made available for the new building by the end of 1914, with some surplus for the installation of exhibits. This can be accomplished by continued exercise of economy, and by some curtailment of the Academy's activities, which under ordinary circumstances should be extended rather than curtailed. The additional funds required for the building will be advanced by the Crocker National Bank, a courteous act, which will be duly appreciated by the Academy.

DONATIONS AND BEQUESTS

The Academy has been the recipient of a number of donations, which have been recorded and suitably acknowledged

throughout the year; and I take this occasion of again expressing the Academy's appreciation of the kindness of these donors in doing their share toward enlarging the Academy's field of usefulness. The Academy is above all an educational institution. Through its collection of scientific material, through the work of its curators, and through the museum exhibits which it maintained before the fire, and which it will re-establish as soon as proper space is provided in the new building, it aims to disseminate knowledge of the world in which we live, and to provide material that would otherwise be beyond the reach of the individual student. That such material flows to the Academy from many sources is an evidence that this fact is appreciated.

During the year a bequest of books and pamphlets was made to the Academy by Dr. William McMichael Woodworth, formerly of California, but in recent years a resident of Cambridge, Mass. This bequest included 235 bound volumes and over 2000 unbound volumes and pamphlets.

ACTIVITIES

During the year which has just drawn to a close the Academy has been as active as circumstances would permit, both in the continuation of research work in various departments, and in the preparation of material for the museum, the building for which—at least so much of it as will be required for immediate needs—we may hope to see completed in Golden Gate Park within this year.

The activities of the Academy along scientific lines will be set forth in detail by the Curators of the various departments. While the Academy's effective work is perhaps best evidenced by the Academy's publications, much has been accomplished which is not found nor referred to in the published material, and which will bear brief notice here.

The Curators and their assistants have worked faithfully in the collection of new material, in the classification and arrangement of the material on hand, and in the publication of the results of the work done.

DEPARTMENT OF BOTANY

Miss Alice Eastwood, Curator of the Department of Botany, besides being active in her own department, has been serving also as Assistant Librarian, and has done much toward perfecting an orderly arrangement of the books and pamphlets which have been accumulating since the destruction, in 1906, of the Academy's original library. She has also proved a valuable aid to the Director of the Museum. She has made large personal collections during the year. The department has been enriched, too, by donations, among which that of L. E. Smith is notable. This consists of 2500 specimens representing 572 species of plants from Northern California. Other donors have added some 500 specimens to the botanical collection, representing nearly the same number of species.

The material collected for the herbarium last year, and much of that which had accumulated in preceding years, was mounted, and some 12,000 mounted specimens have now been made conveniently accessible. They fill seven cases, in which they are arranged according to the latest system. They are labeled, though not all as yet are specifically determined.

A feature of the botanical department is the Botanical Club, with a membership of about 50, which, under the leadership of Miss Eastwood, meets once a week, alternatively at the rooms of the Academy and on excursions.

DEPARTMENT OF HERPETOLOGY

In the Department of Herpetology, Dr. John Van Denburgh, Curator, and Joseph R. Slevin, Assistant Curator, have continued active. The collection has increased from about 28,000 to about 30,500 specimens. Exploration has added the bulk of the new material mainly from California, Nevada, and Utah, with some specimens from the Channel Islands and a few from Arizona. In this department, also, various donors have added to the collection.

The Curator and his assistants have completed the scientific work on the collections from the Galapagos Islands, and the results of the same appear as elsewhere noted in the publi-

cations of the Academy. They have also completed their studies of the collections from Arizona, and the results of these, too, have been published by the Academy during the year.

In this, as in the various other departments, the routine work of caring for the collection and of arranging the specimens has received attention, and the recording of the collection in the catalogue of the department has been brought up to date.

DEPARTMENT OF INVERTEBRATE PALEONTOLOGY

In the Department of Invertebrate Paleontology, Mr. F. M. Anderson, the Curator, and his Assistant, Mr. Bruce Martin, have devoted such time in the field as means would permit to regional studies of minor provinces of the Pacific Coast, with special reference to the Tertiary formations. The field work was extended by Mr. Martin from California into Oregon and Washington, and a large amount of valuable material was collected. Some 21,500 specimens representing about 700 species have been added to the Academy's collection.

The indoor work of the department has related to the preparation of material for publication and to the identification and arrangement of the specimens in the collection.

DEPARTMENT OF MAMMALOGY

In the Department of Mammalogy, under the direction of the Curator, Mr. John Rowley, assisted by Mr. A. E. Bolton, the work of collecting and preparing material for exhibition groups has been continued. There are now mounted and practically ready for installation nine groups, as follows:

Four seasonal groups of Blacktail Deer
One group each of:
  California Mule Deer
  San Joaquin Elk
  Leopard Seal
  Steller's Sea Lion
  Mountain Lion

Groups of the California Sea Lion and of Antelope are also reported to be in an advanced stage of preparation.

The Academy has been liberal in its allotments for the work of this department during the last few years, because it is believed that no better displays can be made to popularize the Museum, and thereby call attention to the facilities for scientific study which the Academy affords.

It is to be added that the work which is being done by Mr. Rowley and his assistants is of an interesting character, and a visit to his laboratory in Berkeley, where the accumulating material is stored, is well worth while.

DEPARTMENT OF ORNITHOLOGY

The Academy's valuable collection of bird specimens is particularly rich in material pertaining to the Pacific Ocean. The collection has received the necessary attention by the Director of the Museum.

This department has furnished during the year one paper on the Birds of the Galapagos Islands by Mr. E. W. Gifford.

DEPARTMENT OF ENTOMOLOGY

In this department, the work of the year under the direction of Dr. E. C. Van Dyke, Curator, assisted by Mr. Chas. Fuchs, has consisted principally in mounting, classifying, and arranging the material brought in from time to time, as well as the material already on hand. This department, as is the case with other departments, has been in cramped quarters, and will benefit greatly by the improved facilities for work and storage which the new Museum building will afford.

The Curator did some collecting in Trinity County. He expresses his appreciation of the aid received from Mr. J. R. Slevin of the Department of Herpetology, and from Mr. Bruce Martin of the Department of Invertebrate Paleontology, the former of whom brought additions to the collection from Arizona, and the latter from Oregon and Washington.

PUBLICATIONS

Four papers have been published by the Academy. Two of these were issued as Parts VIII and IX of the series relating to the Expedition to the Galapagos Islands, and the other two are a continuation of Fourth Series, Vol. III, of the Proceedings, as follows:

Proceedings, Fourth Series, Volume II, Part I

Pages 1–132. VIII. The Birds of the Galapagos Islands, with Observations on the Birds of Cocos and Clipperton Islands (Columbiformes to Pelecaniformes), by Edward Winslow Gifford. Plates I–VII *(Issued Aug. 11, 1913)*.

Pages 133–202. IX. The Galapagoan Lizards of the Genus Tropidurus; with Notes on the Iguanas of the Genera Conolophus and Amblyrhyncus. By John Van Denburgh and Joseph R. Slevin. Plates VIII–XI *(Issued Sept. 1913)*.

Fourth Series, Volume III, Part I

Pages 265–360. A Distributional List of the Mammals of California. By Joseph Grinnell. Plates XV–XVI *(Issued August 28, 1913)*.

Pages 391–454. A List of the Amphibians and Reptiles of Arizona, with Notes on the Species in the Collection of the Academy. By John Van Denburgh and Joseph R. Slevin. Plates XVII–XXVIII *(Issued November 5, 1913)*.

The publication and distribution of these papers involved an expenditure of $2527.13.

THE LIBRARY

The work which, during the past year, has been done on the part of the Library has brought good results. Some room on the shelves has been secured by packing in boxes and storing away a large number of books, pamphlets, and serials which are least likely to be in demand by those who avail themselves of our facilities for reference. The more important books and publications have been roughly classified and made conveniently accessible. The Librarian reports a healthy growth of the Library. The demands of the Curators for scientific works has been fairly well met, and there has been a fair increase through exchanges and complimentary sources, as well as by donations and by the Woodward be-

quest already referred to. It is expected that the Library will be gradually restored to full usefulness after it is properly housed in the new building.

THE SCHOONER "ACADEMY"

The Schooner "Academy," which carried the Academy's exploring expedition to the Galapagos Islands some years ago, has been sold. Upon the return of the expedition, the schooner was sent up to Martinez and cared for there at some expense for watchmen and annual repairs. As no further use for the vessel by the Academy was foreseen, an offer of purchase which was received during the year was accepted.

THE PRESENT SITUATION

The Academy is rapidly approaching a turning-point in its affairs. It will within a year have made suitable provision for the housing of its valuable collections, and will extend its activities in a larger field of usefulness. It has already collected much material for pictorial groups of mammals; the installation of these groups, together with a variety of miscellaneous material, will speedily follow the completion of the new building. The Academy will then be brought into closer touch with the public than it has been for some years, and new and larger responsibilities will fall upon the officers. These responsibilities your officers ask the members one and all to share with them by hearty co-operation in their endeavor to maintain the Academy as a dignified and truly useful institution.

C. E. GRUNSKY
President

II.

GEORGE DAVIDSON

This distinguished member, and we might say founder, of The California Academy of Sciences was born in Nottingham, England, on May 9th, 1825. His parents were Scotch people from Montrose on the east coast. They removed to Philadelphia in 1832, George being then seven years old; and it was here that young Davidson received his elementary education. During his four years at the Central High School, he held the distinction of being continuously at the head of his class. Not satisfied with the knowledge he was gathering at school, the ambitious youth worked in the observatory from 12:20 A. M. till forty minutes before the school opened. This wearing duty was performed at a salary of one dollar a week; but before his school course was finished, the lad had worked this pay up to $30 a month.

During this time his instructor in astronomy, and the master under whom he worked, was Alexander Dallas Bache; and a good friend he proved to the lad so eager to acquire knowledge. Presently Bache was appointed to the head of the United States Survey, and through him young Davidson found his way into the government service. Here he must have worked himself into the notice of the heads of the department, for in 1849 he was selected to perform the important duty of charting the then unknown waters of the Pacific Coast.

Davidson arrived at Yerba Buena (San Francisco) in the month of June, 1850, on the "Tennessee". The working party consisted of George Davidson, Chief; James S. Lawson, A. S. Harrison, and John Rockwell. What by the United States authorities the charting of an unknown coast was considered worth, may be gathered from the fact that Davidson received $800 a year, and his assistants received $30 per month. The Chief had to provide his own board, and on that account was often worse off than his assistants. We notice on the same pay-roll a cook enlisted at $125 per month, with all traveling and subsistence expenses provided. Thus a good cook was considered worth more than two good scientists. Within a space of three years, this little party charted the

whole front coast from San Diego to Port Townsend. Assistance in this great work was rendered by some United States Navy officers then on the coast, who carried on the topography based on Davidson's determinations of latitude and longitude.

From 1854 to 1858 Prof. Davidson was in command of the survey brig "Fauntleroy," and much work was done on the Sound and in the Strait of Juan de Fuca. This involved much exposure. In consequence Lawson, who continued the work, suffered tortures from rheumatism up to the time of his death, and Davidson suffered intensely from neuralgia for years afterwards.

How painstaking he was in regard to his base-lines may be gathered from the following memorandum in the Professor's handwriting, which appears on the back of a photograph of himself in his sister's possession, and which was kindly furnished by her to the writer. It relates to a base measured in 1888–89:

> G. D. January, 1889. At measurement of the Los Angeles base-line, ten and three-fourths miles long, second measurement differed from the first 1/3 inch, third differed 1/120 inch from the second. Worked in measurement, computations, etc., 17 to 18 hours daily for three months.

In 1868 Davidson was placed in charge of the Western Division of the Geodetic Survey, and himself mapped out the work to be done. He never sent out subordinates on difficult or dangerous duty, but went into the field personally. There is not a square mile where the work was carried on in California, Oregon, or Washington, that he did not occupy. His devotion to duty was even greater than his ability and capacity for work.

No other American in the public service received during his life such general scientific acknowledgment from all countries as did George Davidson. He was elected to membership in thirty-two learned societies and academies, including the Royal Astronomical Society, the American Philosophical Society, the National Academy of Sciences, the National Geographical Society, the Royal Geographical Society, and the Bureau des Longitudes of France.

Davidson's signal services to the United States Government were no less remarkable than the honors which were heaped

upon him by foreign scientists. In 1857, by a unique service, he saved the land titles of San Francisco by proving, after sixty hours of continuous work, that the Limantour seal on the claimant deeds was a forgery. In 1862 he was called east to take charge of the engineering work in connection with the defence of Philadelphia against Lee's invading army. He was then placed in command of the armed Coast Survey vessel "Vixen," for work on the Florida coast. In 1867 he was sent to explore the Isthmus of Darien for the purpose of locating a route for a ship canal. From there, Davidson was ordered to make a survey of Alaskan waters, and his report largely influenced Congress to act favorably on the purchase of Alaska. His series of astronomical observations, taken in order to throw light on the problems of the variation of latitude, were termed by German scientists "a gigantic labor." In 1891–92, in a period of fifteen months, he made no less than 6878 observations. During President Cleveland's first administration, he was one of the seven members of the Mississippi River Commission. In 1872 he was selected by President Grant for the important and delicate mission of sounding the sentiment of British Columbia on the annexation question, which was then disturbing that Province.

The existence of the California Academy of Sciences is largely owing to the work which George Davidson did for it during its early history. He became a member of the Academy in 1869, was elected President in 1871, and was reelected each successive year until 1887. He always took a deep interest in the success of the society. His activities did much to give it prominence in the world of science, and to make its meetings conspicuously interesting. If there was no special subject announced to engage the attention of the regular session, he could always draw upon his own inexhaustible fund of scientific knowledge to fill the hiatus. He was always on the alert for eminent scientists, or other notable visitors to San Francisco, who could be induced to address the meetings of the Academy. Conspicuous among such may be mentioned Dr. Louis Agassiz, Captain De Long of the Jeanette polar expedition, and Lieutenant Schwatka returning from his explorations in Alaska. He took the initiative, and did more than any other, to secure from James Lick the magnificent endowment

which has placed the California Academy of Sciences among the wealthy scientific societies of the world. While other officers and members, including Dr. Henry Gibbons, Dr. George Hewston, Charles G. Yale, J. P. Moore, and others, rendered assistance, all his contemporaries in the Academy concede that he was the chief factor in securing the splendid gift. Every member of the Academy should therefore cherish the memory of George Davidson next to that of James Lick as its greatest benefactor.

In addition to his invaluable books, there have been published about three hundred scientific papers by Professor Davidson. In a letter to his sister, he says of his most important works, *The Coast Pilot of California, Oregon and Washington,* 1889, and *The Coast Pilot of Alaska*—Part I, 1869:

> The sailors call my oldest Coast Pilot "Davidson's Bible." I wrote three editions, and then rewrote every line of the fourth, now sent to you. I had about 3500 pages of manuscript, and no fellow has yet found any but a few typographical errors. Remember this big work was done besides my other official work.

That this man, after fifty years of faithful service—a service that called forth unstinted admiration and honors from all maritime nations—should have been treated by his own Government as if he were an ordinary laborer, hired for a day's work, and dropped without excuse or warning, is one of the things for which Americans have often had to hang their heads in shame. In any other country George Davidson would have had honors heaped upon him, and his old age would have been brightened by the thought that the country to which he had devoted his wonderful abilities had not forgotten the sacrifice, but delighted to honor the noble work of such a citizen.

George W. Dickie
Ralph Harrison
Samuel B. Christy
Committee

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NEOCENE RECORD IN THE TEMBLOR BASIN, CALIFORNIA, AND NEOCENE DEPOSITS OF THE SAN JUAN DISTRICT, SAN LUIS OBISPO COUNTY.

BY F. M. ANDERSON AND BRUCE MARTIN,
DEPARTMENT OF INVERTEBRATE PALEONTOLOGY.

CONTENTS

December 30 1914

INTRODUCTION

The Question of the Monterey.—For more than the last ten years California geologists have been accustomed to the use of the term *Monterey Shales,* or *Monterey Formation,* as designating a somewhat definite formational division of the California Miocene, and as belonging to an equally definite time division of that period.

While the full discussion of this interesting question can not be undertaken within the limits of the present paper, there are some reflections that may be offered as prefatory to the subject. If the Miocene strata of California are capable of being consistently subdivided, it should be done, for purposes of intensive study and discussion, if for no other particular object.

The aggregate thickness of the entire Miocene section in California is very great, and the time interval represented is correspondingly long. In many localities in the Coast Ranges the Miocene strata attain or approach a thickness of 7000 feet, and the time required for such a body of strata, largely organic shales, to be deposited is too great to be included in a single time unit if any satisfactory divisions can be found.

While the Miocene deposits of California have not been extensively studied, they are well known to be locally complicated. The exact number and importance of these complications is not yet known.

Undoubtedly the criteria for the final subdivision of this stratigraphic series should begin with the larger events of its physical history. Faunal changes are, of course, important, but they are more likely to be controlled, or influenced, by the physical events, and are therefore of secondary diagnostic value. Next in importance for such purposes is, perhaps, lithology, and lastly, inference, theory, and scientific imagination.

In many cases the order of these criteria has undoubtedly been reversed, and lithology and imagination have been given prominence at the expense of the diastrophic record. The varied conditions of environment in which the faunas of the Miocene were developed, the great variety and composition of sediments, and the complicated physical history of the Cali-

fornia Miocene, all contribute to the aggregate of variety that is met with in the field and in the literature.

While it will be admitted by all thoughtful geologists,—and the idea is by no means new—that lithology can form no proper basis for subdivision of the Miocene, still the thick group of strata of this period, showing as it does the signs of widespread disturbances, can not be considered as being overburdened by formational names when four or five have been proposed. In the early stages of stratigraphic study, if it is at all intensive, such names are necessary and should be welcomed when it seems necessary to the workers in the subject to make them, and they should not be discarded without a proper consideration, nor until shown by creditable authority to be unnecessary. It may be frankly admitted by the advocates of intensive stratigraphic study, without loss to their ideals, that mistakes have been made in the early stages of their work, but this fact should not discourage endeavor to find the order that undoubtedly exists in their subject. The solution of the problem, though not yet complete, is possible; and, if later investigators have erred in their search for proper criteria of differentiation, their endeavors have been toward advancement, and their success, though partial, should be welcomed and encouraged. Their errors, even if great, as they have not been, are no greater than the errors of earlier writers, and if pointed out, may still be amended.

But the difficulties in the way of making a systematic study and a systematic classification of strata should not of themselves discourage effort, nor can the difficulties inherent in the language of science be properly urged as a reason for the rejection of its results. As an example of a regrettable attitude, a recent writer has spent much effort to show that lithology can not form a sound basis of classification, and it is asserted by him that this has usually been the basis among previous writers. This author then proceeds to discourage attempts at subdivision, and endeavors to defend excathedra statements and conclusions that were on the face of them premature, and made before all the facts were known.

It has long been known that organic siliceous shales, such as occur near the town of Monterey, are a "depositional facies" that perhaps belongs to deep-water areas, and that strata of

this type occur in nearly all parts of the Miocene in California, and, in fact, are not confined to the Miocene. The suggestion that this lithologic type is not serviceable for stratigraphic divisions, except locally, is not at all new. Dr. G. D. Louderback has recently made a careful but condensed review of the literature pertaining to the earlier Miocene deposits in California, particularly with reference to the use of the terms *Monterey Series* and *Monterey Formation*. According to Dr. Louderback the usage of writers for one decade was to follow the lead of Dr. A. C. Lawson, who in 1893, proposed the adoption of the name *Monterey* as "the local designation of the series"—represented at Monterey and Carmelo Bay. This "local designation", Louderback interprets to mean, and to include, the whole of the "depositional province", including these localities, and in proof of his contention, quotes the language of a part of Dr. Lawson's text.

Without debating the correctness of this interpretation it may be well to remark incidentally that the extent and limits of this basin or "depositional province" are not defined or even suggested, but presumably it does not extend beyond the boundaries of the California interior valleys. If the same liberty of interpretation be allowed to reviewers of Dr. Louderback's paper that this author assumes in his cursory reviews of others it will be fair to say that his "depositional province" doubtless coincides in extent and boundaries with the Temblor basin described in a former paper by the senior author of this paper.

The papers written during the succeeding decade, 1904 to 1912, show a vigorous and healthy scientific advance, and mark an epoch of progress in geologic study of the California Miocene, and of the Tertiary as a whole. But complaint is made by the reviewer quoted above against the "multiplication of formational names, both within the limits of the ('Monterey') series and throughout the Tertiary terranes", and this increase in formational names is styled "dismemberment", and it is said to be "confusing and rather discouraging to one who wishes to acquaint himself with the real essentials of the geologic history of that time".

In reality this "multiplication" was a direct result of inquiring study into the character and composition of a great suc-

cession of unclassified strata, and its complex history and changing faunas, and it clearly marks an advance in our knowledge of both the physical events of the time and of the resulting facts of deposition and organic development. The adding of three or four formational names was only incidental to the study and differentiation of the strata, and it was evolutionary and unavoidable, if any progress was to be made in our acquaintance "with the real essentials of the geologic history of that time". An increase in names could only be discouraging to one who does not desire an acquaintance with the essential facts, or who assumes an acquaintance that he does not possess, or by one who is unaware of the value of intensive study.

Within the limits of California there is much to be done in the way of finding a proper basis of stratigraphic classification of the Miocene, and its faunal changes. The area described in the second part of this paper, like many others that should be better known, has its own contribution to make toward the final result, and will serve to illustrate anew an interesting problem, and to some extent show the complicated nature of the Neocene provinces and their environments, and their phases of deposition. Faunal differences have hitherto been ascribed to progressive time development, and inland districts having faunas somewhat different from those along the present coast have been pointed to in proof of such contention, on the theory of a gradual subsidence and progressive continental transgression. The soundness of this view has still to be proved.

It has yet to be shown that the so-called *Vaqueros* beds of the Salinas valley are older in time than the Temblor deposits at the base of the Miocene within the Great Valley. Little or nothing is gained by assuming as settled facts, views that upon last analysis will be shown to be purely speculative.

During the past several years considerable stratigraphic and areal work has been done in and about the oil and gas districts of central California by the writers of this paper, and by those who have contributed to the information and fossil materials herein represented. This work has extended not only over the proved oil districts of the San Joaquin Valley, or better, the Temblor Basin; but following the lead of prospective evidences of oil it has extended into neighboring territory and into outlying districts which have contained only doubtful evidences

of petroleum, or where only stratigraphic resemblance allied them to the oil-bearing formations in other districts. This work has necessarily covered much territory outside of the limits of proved or even prospective petroleum lands. But nevertheless it has thereby led to a broader and better understanding of the stratigraphic conditions of the oil bearing formations, and of other associated strata, above and below.

However, not all of the work upon which this and subsequent papers are to be based was done as economic exploration, for much of it in fact was done for purely scientific purposes, or solely to extend the boundaries of geological and paleontological information farther than it had heretofore been carried, and to solve, or aid in solving some of the problems with which these subjects abound. While the distribution and correlation of the larger divisions of the middle Tertiary of California are well known, there are, nevertheless, points of interest in correlation which have not been finally settled, and any additional knowledge that can be added seems fully worth while. The familiar and much debated question of the relation of the lower Miocene of the interior basins to those of the coastal districts has interested the writers in areas intermediate between the Kern River region, the most easterly occurrence of lower Miocene within the Great Valley of California, and the Salinas Valley where lower horizons are supposed to occur. An area some twenty-five miles long and approximately ten miles wide, stretching from Paso Robles in the Salinas Valley southeast to the western border of the Carrizo Plain, was examined and partly mapped, and studied with a view to throwing light on this problem of correlation. The results of this work, while not yielding all that was desired, seem to warrant a brief description as to stratigraphic relations, together with a faunal correlation as far as can be made.

The geology and faunas of some of the outer coastal districts have been studied by H. W. Fairbanks, J. C. Merriam, Ralph Arnold, and the present writers, while areas within the Great Valley have been similarly studied by several workers, including Ralph Arnold, Robert Anderson, H. R. Johnson, and the writers. Meanwhile, the areas lying along the southern border of the Temblor Basin west of the Great Valley and inter-

mediate in position, have generally escaped the notice that they have deserved. Aside from the brief reference by Antisell in the Pacific Railroad Reports, there are only meager accounts of their geology or paleontology to be found in the literature of California geology.

Among these lower Miocene localities are those in northern San Luis Obispo County, as well as the locality on Los Vaqueros Creek, Monterey County, from which the name "Vaqueros Formation" has been derived. The additions here made to the lower Miocene fauna of California come from a more exhaustive study of these deposits, and of those on the Kern River along the eastern border of the Temblor Basin. In no other part of the province of geology is the value of intensive stratigraphic work and of invertebrate paleontology as an aid, more clearly disclosed than in the systematic study of the marine oil-bearing formations of California. It is not difficult for the paleontologist familiar with these horizons and their faunas, to follow or identify them in districts outside of productive fields, and thereby in some measure judge of the merits of untried areas. Much of the pioneer development work of the oil districts of this state has been guided consciously or otherwise by "fossil shells", even by unscientific operators.

In a systematic study of the various deposits, economic and other, that belong to the Pacific Coast Tertiary, there are not only practical and local problems, but there are problems of provincial, regional, or even continental extent that require consideration, and which can not be overlooked by the philosophic student who would correctly understand his data. For this purpose it would be desirable to know much about the climatic conditions of the Tertiary, and the environment of its local faunas. Too little attention has hitherto been given to these and similar phases of West Coast geology.

However, it is not the purpose to undertake an extensive discussion of stratigraphy, faunas or climate in the present paper, but merely to suggest the subjects, which, it is hoped, will be further treated hereafter and incidentally to introduce into the literature a few of the hitherto undescribed invertebrate species in advance of subsequent discussions.

The new species and subspecies of marine mollusca described in this paper have been obtained from the middle and lower Miocene of central California and other provinces at various times during the last two or three years. Among the contributors of material to this paper have been Mr. R. B. Moran, Mr. W. H. Ochsner, Mr. A. G. Carpenter, Mr. John P. Buwalda, Mr. Charles Morrice, and the writers. The field work and mapping of the San Juan district and the discussion of its geology and other features is the work of the junior author.

NEOCENE RECORD IN THE TEMBLOR BASIN

The Temblor Basin

This basin has already been defined as occupying the larger part of the Central Valley of California and the neighboring intermontane valleys to the west. It is more accurately represented on the map (Plate 9) which shows it bounded on the west and south by the Santa Lucia, San Raphael, the San Emedio and Tehachapi ranges, and on the east by the foot hills of the Sierra Nevada. It is not known to extend farther north than the Marysville Buttes, though Neocene and older Tertiary strata may occur there. An inspection of the map shows the Temblor Basin to be divided by mountain ranges extending through it from southeast to northwest, beginning near the San Emedio Range at the south and extending north to the Straits of Carquinez. These ranges form two groups running nearly parallel, but diverging toward the northwest. Toward the southeast they approach or merge into each other in the region of Coalinga.

The Mount Diablo Range forms the more easterly group and is more continuous and more important than the other, which includes the San Jose, Gavilan, Santa Cruz and other intervening minor ranges.

Several small intermontane valleys are enclosed among these mountains, including the Carrizo, Cholame, Peachtree, San Benito, and Santa Clara valleys, and a few others of smaller size.

Mount Diablo Range.—The Mount Diablo Range embraces a number of minor ranges that are more or less separated and distinct, though having a greater measure of continuity than

the more westerly group. Among its units are included the Temblor, Avenal, San Benito, Panoche, Mount Hamilton, and other ranges of less importance. J. D. Whitney divided the Mount Diablo Range into six sections which he believed to be more or less distinct. For the most part these divisions are offset from each other, having a somewhat *en echelon* arrangement, forming spurs that project in turn into the Great Valley. This fact has been mentioned before, and was first described by the senior author in 1903, in a paper read before the Cordilleran Section of the Geological Society of America[1] though it was not mentioned in the published abstract. The causes and significance of this peculiar and interesting condition have never before been explained, and it is one of the aims of this paper to call attention to it as one of the most important facts to be considered in the study of the diastrophic record of the California Neocene.

Neocene Deposits.—While the larger portion of the Neocene deposits of California is included in the Temblor Basin there are important areas in the coastal valleys to the south. It is believed that the most complete, and therefore the most representative, deposits of the California Neocene are to be found within this larger basin. If older Neocene strata exist outside of this area their existence has not been proved, and it appears to be unlikely that any do exist.

The Mount Diablo Range occupying as it does a central position in this basin should furnish the most reliable key to the physical history, stratigraphy, and classification of the deposits, which are here most representative of the Neocene of California. While Neocene deposits are found in all of the intermontane valleys among the interior ranges, their most complete development is found either within the drainage of the Salinas River, or in some respects, better still, on the eastern flanks of the Mount Diablo Range, as will be shown hereafter. The eastern flank of this range occupies the most central position of the basin. Descriptions of some of these Neocene strata have already been published in the several papers devoted to different portions of the range,[2] and in the

[1] Bull. Geol. Soc. Am., Vol. 15, pp. 581 and 582.
[2] Proc. Calif. Acad. Sciences, Vol. II, No. 2;
Proc. Calif. Acad. Sciences, Vol. III, pp. 1-40;
Bull. No. 398, U. S. Geol. Surv., pp. 46-179;
Bull. No. 406, U. S Geol. Surv., pp. 31-107.

second part of this paper devoted to the Geology of the San Juan district.

Structures.—The Neocene structures now found in and about the Temblor Basin, and illustrated by the structures in the Mount Diablo Range, are the final result of far-reaching geo-dynamic activity that has operated through several periods and epochs of geological history. The general aspect of the Geomorphic Map of California and Nevada shows the results of compressional stresses that have acted from east to west in the extensive wrinkling of the surface. This dynamic activity probably began in Mesozoic time or earlier, but it is certain that a large part of the distortion of the later strata was effected in Tertiary or post-Tertiary time. In fact, as will be shown later, much of it must have been accomplished in middle or early Miocene time.

The general effect of this activity or tangential thrust is expressed in the Mount Diablo Range in two important ways, each of which is better exhibited here than in any other part of the basin.

One of these effects is the widespread longitudinal folding of the Tertiary and older strata along the flanks of the various divisions of the range, as is to be seen in the several anticlines and synclines along the eastern flank of the range and in and about the oil districts, and on the San Juan River.

Another effect is the breaking up of the main range into orogenic blocks, as will be shown later, each having a more or less independent diastrophic history. The structures herein described are at one with, and dependent upon, the diastrophic movements of the several blocks or divisions of this range, and this is what should have been expected. An inspection of the structures depicted on the maps of the Coalinga and McKittrick-Sunset districts shows a general system of folding which involves all of the Neocene strata about the several oil districts from Coalinga to Sunset. The principal folds, anticlinal and other, follow a somewhat northwest to southeast course which is in a measure parallel in all of the more northerly districts, but which turns more easterly at the south.

These foldings, as well as their grouping, will be seen to have a definite and consistent relation to the faulting that has taken place chiefly at right angles to the general axis of the

Mount Diablo Range. Some of these faults may be mentioned in this connection, but will be dealt with later. One of these may be called the Antelope Valley fault and is imperfectly described by Arnold and Johnson as traversing the northern border of the Antelope Valley.

Another is the Bitterwater fault which crosses the northern end of the Temblor Range, extending in a northeast to southwest direction.

A third is that described by the same authors as the Temblor fault, cutting obliquely across the range from east to west near the Temblor ranch house. Other minor faults may be noticed from an inspection of the map, but not all of them are well shown in detail on the published maps.

The San Andreas fault, although it traverses the eastern border of the San Juan district, has had little or no effect upon developing any of the structures to be seen therein, or to be seen in any part of the neighboring region. It clearly is of recent origin and its importance belongs almost entirely to the present epoch and to the human settlement of the country. The amount of horizontal displacement along its course is hardly noticeable.

Orogenic Blocks.—The breaking up of the Mount Diablo Range into separate blocks, and the divisions recognized by Whitney, have already been referred to. The following sketch

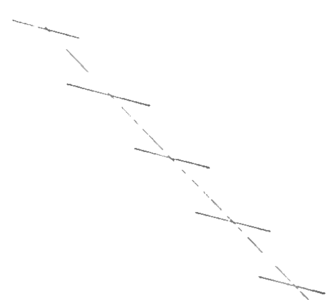

Figure 1.—Diagram showing the en echelon arrangement of the different parts of the Mount Diablo Range.

to illustrate the general facts was made use of in an earlier discussion[1] of the stratigraphy of the southern Coast Ranges

Bull. No. 406, U. S. Geological Survey, p. 100, et seq.

[1] Unpublished manuscript 1903. See Abstract, Bull. Geol. Soc. Am., Vol. 15, pp. 581-582.

of California. A full discussion of this interesting topic can not be given at the present time, but some suggestions are offered.

As is partly shown on the areal map of the McKittrick-Sunset district, one of the main effects of the disturbances which produced the transverse faulting is seen in the offsetting of the several formational zones cut by them, with a wide lateral displacement of the northern blocks to the eastward with respect to the others. This lateral displacement is best shown in the abrupt termination of the several belts. The offsetting of the Temblor (Vaqueros) beds is not less than that of the Cretaceous, which is not small, amounting to approximately three miles in the case of the Bitterwater fault, and possibly to even more in the case of the Antelope Valley fault. Interesting suggestions are also to be seen in the distribution of the Temblor (Vaqueros) rocks along the line of the Temblor fault and also the minor faults not named. On the other hand the Monterey shales, as mapped on the McKittrick-Sunset sheet, show no appreciable offsetting on some of these faults, while on others they do. In the case of the Temblor fault the Monterey shales are overlapped by later, perhaps Etchegoin beds, and if there is any offsetting it is obscured or hidden. On the Bitterwater fault there is no offsetting of the Monterey, and this is known to be the case on the Antelope Valley fault, or on its projection westward beyond the boundaries of the map.

It would appear from these observations that the faulting and offsetting of the formations took place chiefly during middle or early Miocene time, after the deposition of the Temblor beds and prior to that of the Monterey shales, though some similar movements may have occurred since.

Similar facts of discordance, and other corroborative evidence of this order, are to be observed in other parts of the Temblor basin and in districts outside of it, as will be shown later. The displacement of the Cretaceous and the Temblor on the Antelope fault and other eccentricities and discordances of stratigraphy and sequence emphasize the individuality of these several orogenic blocks. North of the Antelope Valley, the Tejon, upon which the Temblor appears to rest conformably, is well developed. South of the Antelope Valley

no Tejon is shown, and the Temblor rests upon Cretaceous or Franciscan rocks. The development of the Temblor group north and south of these fault zones is as uniform in thickness, lithology, and fauna, as could be expected. On the south, between the Temblor and Antelope valleys, the Temblor strata are from 1000 to 1500 feet thick. On the north, as developed about the Sunflower (McClure's) Valley, it may vary from 500 to 1500 feet, as exposed at different points. It is quite possible that the shales overlying the terriginous sandstones in this locality should be included with the Temblor.

As regards the Monterey north and south of these fault zones, there is very great discrepancy in thickness and development. South of the Antelope Valley thick beds of Monterey are indicated on the map, and near Carneros Springs these beds are little less than 3500 feet in thickness. Earlier estimates of these strata included beds that probably are of Santa Margarita age. It is doubtful, on the other hand, if Monterey strata exist at all north of the Antelope Valley, and none is shown on the map of the Coalinga District. It is useless to argue about the difficulty of discriminating here between Temblor and Monterey upon the basis of lithology or any other character. The fact remains indisputable that the Miocene beds north and south of these fault zones are entirely different for all parts of the section above the Temblor. These facts are entirely explainable upon the assumption of distinct orogenic blocks having independent and separate diastrophic movements after the close of the Temblor epoch, but they are not readily explainable upon any other basis.

A study of the Mount Diablo Range as a whole discloses the fact that it consists of a number of orogenic areas that differ in various parts of their Neocene stratigraphy. One of these areas or blocks comprises the Temblor Range adjacent to the San Juan district. A minor block is enclosed between the Antelope Valley and the Bitterwater faults, and is of triangular shape. A larger block embraces that part of the range between the Antelope Valley and the Waltham Creek valley, and still other blocks may be defined north of Coalinga. Many of these blocks, which are in fact separate diastrophic areas, were noted by Professor Whitney in his subdivisions of the Mount Diablo Range. The extent to which this subdivision of the

range could be carried is not known, but it is sufficient for the present purpose to point out the fact that there are separate orogenic blocks within the southern portion of the range. Two important results of this breaking up of the range may properly be noticed here, though the full treatment of the subject must be deferred.

The first point of importance is the accord shown between the displacements due to thrust-faulting, and the folding, or wrinkling of the strata. In the case of the Avenal block, lying to the north of the Antelope Valley, the tangential shortening of the section is effected by folding on the eastern side of the range, as is seen in the anticlines and synclines about the Sunflower Valley and the Kettleman Hills. In the case of the Temblor block the shortening has taken place mainly on the Carrizo side of the range, as is to be seen in the anticlinal folding in the San Juan district, though to a less degree on the eastern side in the high inclination of the Miocene strata along the eastern slopes. In what may be known as the McKittrick-Midway block the folding and shortening is again largely on the eastern side of the range, as may be seen about these oil districts in the various anticlines and synclines as already stated.

Had the strata of the San Juan district been sufficiently rigid to have withstood the thrust from the southwest without crumpling, the Temblor Range would have been carried farther eastward, with the development of greater or more numerous folds on the eastern flank.

In accord with this the offsetting of the strata would have been much less along the transverse fault line, bounding this block on the north.

The second point of importance to be noted in connection with the breaking up of the range into orogenic blocks is the separate and independent vertical movements noticeable in the case of each. For just as there have been differential horizontal movements with respect to each other, there have also been vertical movements, showing the general independence of each orogenic block. This is shown in the well known discrepancies in the Neocene stratigraphic sequences of the various blocks, but the subject is too large to receive an extended treatment here.

Disturbances noted elsewhere.—Reviewing briefly some of the corroborative evidences of wide-spread disturbances in early Miocene time attention may be called to the following: 1904, H. L. Haehl and Ralph Arnold showed that eruptions of diabase and basalt took place during the early Miocene. We read: "The diabase breaks through beds of lower, and perhaps middle, Miocene age; while the associated diabase tuff is interbedded with strata containing a typical lower Miocene fauna and lies below the Monterey shale. The basalt outflow exposed near Stanford University overlies and metamorphoses beds of lower Miocene age, and is overlain by beds containing a fauna very similar to the underlying strata. This evidence indicates the lower Miocene age of the basalt and its probable contemporaneousness with the diabase of Mindego and Langley Hills".[1]

These facts are in accord with the unconformity shown in the discordance of dips between "Monterey strata and those of the Vaqueros sandstone" described in the same district.[2]

Attention may be called here to the intrusion of diabase into the Temblor beds of the San Juan district.

In the vicinity of Edna, and south of San Luis Obispo, Temblor beds are found overlaid with thick strata of rhyolite tuff, and this in turn is covered by a greater thickness of Monterey shales. With the exception of the Temblor (Vaqueros) beds these facts are well represented on the geologic sheet of the San Luis Folio. However, the Temblor beds are well exposed with many characteristic fossils directly south of San Luis Obispo and east of the creek of the same name. On the geologic sheets these Temblor beds are represented as Monterey. However, as they contain *Turritella inezana* Conrad, *Pecten magnolia* Conrad, *Conus hayesi* Arnold and *Dosinia whitneyi* Gabb, the lower Miocene (Temblor) age need not be questioned. It is not unlikely that these rhyolite beds are genetically connected with eruptions of considerable magnitude that have occurred about San Luis Obispo. These beds of tuff extend in a south-easterly direction toward Santa Maria and beyond, and are covered by beds of siliceous shales, as they are near San Luis Obispo.

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[1] Proc. Am. Philos. Soc., Vol. 43, p. 18.
[2] Santa Cruz Folio, descrip. text, p. 4.

Quite similar beds of ash or tuff, though not so thick, occur in the lower Miocene beds of Point Sal, as described by Dr. Fairbanks.[1] It is quite likely that the ash beds at Point Sal are a part of the same general outburst that spread the ash and tuff over the San Luis quadrangle not far distant. There are many geological facts in all parts of the Coast of a similar nature. The tufaceous beds in the lower Miocene of Kern River need only be mentioned in this connection.

A time correlation of all these facts of disturbance, eruptions and stratigraphic discordances, etc., is obviously suggested by the facts themselves, and it is most likely that the same geodynamic action was the prime cause of them all, which thus found various expression in different districts.

Neocene Record.—With the exception of the diastrophic events related in the preceding pages as intervening between the Temblor and Monterey epochs, and their respective stratigraphic groups, the major Neocene disturbances are fairly well illustrated in diagramatic form in a former paper.[2] The portion of the curve representing the Temblor-Monterey subsidence should show interruption and unconformity, to some extent at least, and in this respect it will conform more closely to the sequence of events suggested by Dr. J. P. Smith in a tabular statement giving the Neocene Sections of California.[3]

This classification recognizes the main historical facts that have been demonstrated in the Neocene record of California. The order of events may be summarized as follows:

1. A subsidence, possibly gradual, that led the sea into the Temblor Basin, with the development of an important series of deposits known as the Temblor group, containing a well developed subtropical fauna.

2. An interval of disturbance, uplift and displacement that interrupted the continuity of sedimentation in many parts of the coast. These disturbances were accompanied by considerable volcanic activity that spread both basic and acid lavas and tuffs over land and sea, as is especially shown about the southern borders of the basin and in the neighboring districts

[1] Bull. Geol. Dept. Univ. Calif., Vol. II, p. 16.
[2] Proc. Cal. Acad. Sci., Vol. III, p. op. 118.
[3] Jour. Geol., Vol. 18, p. op. 226.

December 30, 1914.

to the south. Possibly these coastal eruptions can be identified with some of the earlier Neocene volcanics of the Sierra Nevada, and the Great Basin region.

3. A slow and prolonged subsidence that effected the development of a great accumulation of strata known as the Monterey group, or "Monterey formation". In most parts of the Coast this group consists largely of organic siliceous deposits of diatomaceous shales, though containing other materials as well. It is not coextensive with the Temblor group in area, either within the Temblor Basin or outside of it. Its fauna is scant and of boreal aspect, and it marks a distinct change in the physical geography of the time.

4. Uplift and folding and an interval of denudation and erosion, that must have been far reaching as shown by its effects upon faunal development in the epoch following.

5. Subsidence that again extended the sea in the Temblor Basin with the development of thick deposits of largely terriginous sediments, not coextensive in area with the preceding Monterey group, and resting unconformably upon it. This subsidence was not so profound as that of the Temblor or Monterey epochs and led to the reintroduction into the basin of subtropical species, as is shown in the faunas of the Santa Margarita (San Pablo) deposits throughout the central California coast.

6. Uplift and local denudation, that again interrupted the continuity of sedimentation in many parts of the basin and probably in other regions, and that was of sufficient extent in time or place to again effect important faunal developments, as shown in the succeeding group.

7. Subsidence that once more rearranged the distribution of land and sea about the Temblor basin, with the development of a new group of sediments known as the Etchegoin group, not coextensive in area with the preceding Santa Margarita (San Pablo) group, and not containing the same number

or percentage of subtropical species. This epoch of subsidence did not terminate entirely until the final uplift that closed the occupation of the basin to marine conditions.

8. Uplift that expelled the sea from almost the entire basin, and left it under oscillating conditions only in the deeper portions of the same. This interval of uplift and oscillation developed the subgroup of upper Etchegoin strata which contains an alternating series of marine and freshwater sediments and faunas in the deeper portions of the Great Valley.

9. Differential local uplifts that expelled the sea entirely from the basin but impounded and retained an extensive body of freshwater within the Great Valley, in which were subsequently developed the series of sediments known as the Tulare group. The Tulare should probably be correlated in time with the marine Merced group which is well developed about the seaward outlets of the Temblor basin and in other similar situations along the coast.

10. The general, or continental, uplift that brought the final close of the Neocene and initiated the Pleistocene and its widespread terrestrial conditions.

Conclusions.—It is a well-known fact that the development of the Neocene in central California, where its largest area exists, is very great, at several places being not less than 6000 feet in thickness. It is evident that this basin should therefore be regarded as containing the most representative section of these rocks in California.

For purposes of intensive study this enormous aggregate of strata should be divided into as many groups and divisions as the geological facts in the case will sustain. The facts of prime importance bearing upon this problem are those connected with the physical and dynamic history of the period. The first object to attain in its solution is the clear understanding of its diastrophic record.

That there is considerable complexity in the diastrophic record of the Neocene in its most representative areas is evident to any one familiar with the literature and with the facts

throughout the field. In the Mount Diablo Range there are three diastrophic events, perhaps of epochal duration, marked by wide stratigraphic displacement, crumpling of strata, discordance and unconformity. The earlier of these events took place in early Miocene time, and was accompanied by much volcanic activity. As an event in the physical history of the Miocene it serves as a proper basis for the separation of two stratigraphic groups of Miocene strata. The older group, from its occurrence along the eastern flank of the Temblor Range, has been described as the Temblor group, and it is representative of the lower Miocene throughout the Temblor Basin, and probably throughout the entire state.

The second group of strata is that which is locally well developed in the Temblor Basin, and which may be referred to as the "Monterey formation", as entirely distinct from the Temblor group. This separation is not made upon the basis of lithology, though incidentally for most parts of the basin the group, or "formation" is characterized by siliceous organic shales of a peculiar nature.

The second diastrophic event is that which resulted in the great discordance and widespread unconformity within the Temblor Basin between the Monterey group and the next succeeding group, which is here called the Santa Margarita. This event is not known to have been accompanied by volcanic outbursts of great importance, but was chiefly characterized by uplift, erosion and subsidence, and by differential warping of the land surface.

A third diastrophic event divides the record of the later Miocene, and is recorded in the unconformity of the Etchegoin group upon the Santa Margarita, and the wide overlap of the former upon rocks much older than the Miocene.

Other uplifts of lesser rank have affected the Neocene series in various parts of the Coast, and of this basin, but their full treatment is beyond the limits of this paper.

The latest Neocene group is partly of freshwater character and partly marine. It is the Merced-Tulare that may in part, or as a whole, be regarded as later than the Orinda formation of the Berkeley Hills.

Lithologically, there is considerable difference in the composition of the several groups of Neocene strata herein de-

scribed, but while some of these differences are more or less constant they can not serve as a basis of a division into formational groups, except locally, and with some reserve.

The areal mapping of the various groups of the Neocene is attended with the same sort of difficulties as the stratigraphic determination, and for the same reasons.

Paleontology is a useful aid in making, or rather in identifying, the divisions, but the final word has not yet been said as to the range of species; in fact, there are still many undescribed species to be found in different portions of the series. Among the important facts to be considered in connection with the faunas as reflecting the changes in physical geography is the alternation of sub-tropical and boreal faunas, in the principal divisions of the series, the Diatomaceæ being of boreal aspect.

THE SAN JUAN DISTRICT

General Statement

Location.—The territory comprised in this district includes a relatively small area in the north-central part of San Luis Obispo County extending from the Carrizo plain northwestward to the Salinas Valley, thus covering the northwestern end of the Carrizo Valley and the northern flank of the San Jose Range, west to Creston and beyond. This district includes, therefore, the southern border of what is sometimes known as the Estrella Valley, and is included within the drainage of the San Juan and the Estrella, a main tributary of the Salinas River. The area lies intermediate between that of the San Luis Folio mapped by H. W. Fairbanks, and that of the McKittrick-Sunset District mapped by Arnold and Johnson. The areal geology is therefore in a measure tied to each of these areas. In a topographic and in a structural sense it lies between two of the more important ranges of this region, namely the San Jose and the Temblor ranges. The former borders it on the southwest as a massive abutment, and the latter, as the southern unit of the Mount Diablo Range, separating it from the Great Valley. It may be considered as belonging to the southeastern end of the Salinas branch of the Temblor Basin, with which it was almost solely connected in later Tertiary time. (See map, Plate 10).

The San Jose Range is the dominating feature of the district on the south. It rises to a maximum elevation above 4000 feet. The numerous spurs and ridges descending from it have no definite orientation, but strike obliquely or at right angles from the main divide, which trends in a northwest and southeast direction.

While the general area of the San Juan district is but little less than 2000 feet above sea level it has relatively low relief when compared with the more rugged topography of the neighboring range. The hills are well rounded and the slopes gentle. The low ridges and spurs have a general northwest and southeast direction, conforming to the larger topographic features. Recent stream erosion has cut deeply into the softer Tertiary formations, and all of the streams, and even the larger gulches and ravines, have fairly well-developed flood plains within the area of these formations. Within the area of older rocks the ravines and gulches are steeper and narrower, and with hardly any flood plains developed.

GEOLOGY

Basement Rocks.—The basement on which the Neocene and later sediments rest in the area covered by the mapping is almost entirely of granite. There are a few scattered patches of limestone in this area but they are mostly small and relatively unimportant. They are probably remnants of some paleozoic formation into which the granite has been intruded. A larger body of such limestone lies outside of the area covered by actual mapping, toward the north. It makes up a large part of the floor of Cholame Valley to the north and east of Shandon.

The boundaries of the basement rocks have not been mapped in detail. They compose the general areas of the Coast Ranges which represent the insular land masses of the early Neocene in the Temblor Basin. The San Jose Range lying immediately to the south of the San Juan district is composed almost entirely of granite. Along the eastern flank of the granite on the upper tributaries of the San Juan there are some sandstones and shales that are probably Cretaceous, and both Cretaceous and Eocene rocks are found in the Temblor Range and are indicated on the areal map of the McKittrick-Sunset district.

Neocene Rocks.—The oldest sedimentary rocks with which we are directly concerned are of lower Miocene age and belong to the Temblor group. The Temblor sediments range in character from conglomerates and coarse granitic sandstone at the base to finer sandstone, sandy clays, and argillaceous shale at the top. The coarseness and composition of the rocks and their hardness vary considerably, and there are few sections that are alike in sequence and character, although coarse materials predominate at the bottom and finer materials at the top, as a rule, and in this respect there is some uniformity.

The rocks of the Temblor group occupy a long narrow strip of varying width extending from the Salinas Valley, near Atascadero, southeast to San Juan River and beyond. In a few localities stream gravels and alluvium have completely covered these beds so that they can not be traced continuously across the district. One notable occurrence of this alluvium may be seen between Cammattii Canyon and Navajoa Creek in the northern part of T. 29 S., R. 16 E. The general strike of the beds is N. 60° to 70° W. in the western part of the area and about N. 40° to 50° W. in the eastern part of the district near La Panza. They dip away from the granite toward the northeast at angles which rarely exceed 30°.

The lowest beds of the group rest directly upon the eroded surface of the granite, there being no intervening marine sediments such as are found elsewhere in the Coast Ranges of California. Between the marine sandstone and the unaltered granite there is a zone of weathered granite consisting of numerous large boulders and angular fragments which do not show the rounded surfaces so characteristic of water worn materials. The degree of weathering shows every gradation from slightly weathered granite to coarse arkose sandstone, so that in some localities it is difficult to draw a sharp line of demarkation. In the N. W. ¼ of Section 26, and the N. E. ¼ of Section 27, T. 28 S., R. 14 E., there are several good exposures of this zone of weathered granite. These exposures occur in the canyon walls and the creek banks near the county road. Above this zone of weathered granite there are several hundred feet of coarse granitic sandstone. The degree of compactness varies considerably, many well-cemented layers being interstratified with softer materials. Overlying the coarse

sandstone are several hundred feet of softer, medium grained sandstone. Near the middle of the section there is 100 feet or more of coarse granitic, well cemented sandstone containing a few fossils, among which *Scutella norrisi* Pack, is the most characteristic. Above this coarse fossiliferous sandstone there are several hundred feet of medium to fine grained sandstone and sandy clays. Near the top of the section, immediately beneath the overlying shales, the beds are essentially soft sandy clays with a few thin seams of tawny colored limestones. This section may be considered representative of the Temblor in the western part of its area.

East of the San Juan River in the N. E. ¼ of T. 30 S., R. 17 E., a different sequence of sediments is exposed. Here a rugged and conspicuous mountain mass lies between San Juan River and the western border of the Carrizo plain. When seen from a distance this prominent ridge appears much like the granitic hills west of the San Juan River, and might easily be mistaken for such. On closer observation, however, it is found to consist of massive thick-bedded gray sandstone, usually coarse grained and conglomeratic, but having interspersed through it thin beds or layers of clay shale. This massive sandstone, when compared with the beds a few miles to the northwest, could easily be mistaken for this older formation. The finding of well preserved Temblor fossils near the base, however, has shown it to be only a special development of the Temblor beds. Near the top of this section the sediments become soft, fine grained, sandy clays, that grade into clay shales of the character common in the Monterey, but as a good fauna of Temblor species is found in the beds overlying it there can be no mistake that it is also to be included in the Temblor.

The Temblor group of this section can be separated into three distinct lithological divisions. The lowest member is that already described. The next division consists of sandy clay shales and fine grained gray or brownish sandstone with which are interstratified numerous thin layers and lenses of limestone, some of them sparingly fossiliferous. The sandy gray shales resemble lithologically some of the strata of the overlying Monterey. The third member of the group is a brownish or gray, arkosic sandstone of medium or coarse texture several

hundred feet in thickness. With it are associated several small areas of diabase which occur as intrusions into the sedimentary rocks. Overlying the coarse granitic sandstone are several hundred feet of rather brownish fine sandstone and clay shales. Numerous well preserved fossils have been obtained from this upper member of the Temblor.

The average thickness of the Temblor group in the western part of the area is between 1000 and 1500 feet. In the section just described between the west border of the Carrizo plain and the San Juan River it probably exceeds 2000 feet.

Farther to the southeast the Temblor group attains a still greater thickness, probably exceeding 2500 feet, where it includes one or more beds of white or rusty siliceous shale. This is part of the thick series of Miocene rocks referred to in a former paper by the senior author in which the estimated thickness was greatly exaggerated on account of folding and reduplication.[1]

The section of the Temblor group east of the San Juan River recalls the type section of the Temblor which is less than 20 miles to the northeast, on the eastern slope of the Temblor Range near the Carneras Springs. As stated in the original description, the middle member of the Temblor beds consists of about 600 feet of "siliceous and clay shales with interstratified sandstone".

These Temblor beds are mapped on the geological sheet of the McKittrick-Sunset district as two narrow parallel zones of "Vaqueros" strata separated by a thick bed of "Monterey Shale."[2] Similar occurrences of the Temblor group have been noted in other districts, and in fact are not rare. The association of diabase with the Temblor as intrusions near the top of the group will be referred to again. These rocks are shown on the extreme western border of the McKittrick-Sunset map, though in not very accurate detail.

The small area of strata indicated doubtfully as Oligocene on the same map is probably the shale member of the Temblor and lies stratigraphically between two well developed zones of the same, in both of which are many undoubted species of Temblor fossils. From the uppermost member of the Temblor group at this point were obtained the following species:—

[1] Bull. Geol. Soc. Am., Vol. 15, pp. 581-582.
[2] Bull. No. 406, U. S. Geol. Surv., pp. 47-50.

Cardium vaquerosense Arnold.
Chione temblorensis Anderson.
Phacoides richthofeni Gabb.
Pecten andersoni Arnold.
Venus pertenuis Gabb.
Conus hayesi Arnold.
Conus owenianus Anderson.
Nassa arnoldi Anderson.
Neverita inezana Conrad.
Oliva californica Anderson.
Pleurotoma dumblei Anderson.
Trochita, sp.
Trophon gabbianum Anderson.
Turritella ocoyana Conrad.

Faunal Relations of Temblor.—A large number of well preserved marine invertebrates was obtained from nearly all horizons in the Temblor of the San Juan area. The greater portion of them, however, came from strata near the middle of the section where the character of the sediments is most favorable for the preservation of organic remains. In comparing this fauna with that obtained from the lower Miocene of other localities, such as the Kern River district, Kern County, and Los Vaqueros Valley, Monterey County, it will be seen that nearly all the Temblor species found in the San Juan district occur in the Temblor group of Kern River, while some of the species most characteristic of the lowest horizon, in Los Vaqueros Valley have not been found in the San Juan district. There is some evidence, however, that the Temblor of the San Juan district is not far removed, stratigraphically, from the lower horizon of the Los Vaqueros Valley, which has been referred to as the Turritella inezana Zone. In the Los Vaqueros Valley, *Scutella norrisi* Pack occurs with *Pecten sespeensis* Arnold, *Thais vaquerosensis* (Arnold), *Turritella inezana* Conrad, and a number of other species which are common in both horizons of the lower Miocene of Kern River and the San Juan district. In the San Juan district, *Scutella norrisi* Pack and *Astrodapsis merriami* Anderson occur together in a coarse sandstone near the middle of the series in Sec. 30, T. 28 S., R. 15 E., East of the San Juan River along the north edge of Sec. 3, T. 30 S., R. 17 E.,

Scutella norrisi Pack occurs in a massive, coarse sandstone a short distance below a very fossiliferous horizon which contains a large number of species that are common in the Temblor of the Kern River district. *Scutella norrisi* Pack has been considered to be characteristic of a lower horizon of the lower Miocene in the valley districts, and the finding of this species associated with *Astrodapsis merriami* Anderson, in rocks only a short distance below beds containing the typical Temblor fauna, makes it appear that the Turritella inezana Zone and the Turritella ocoyana Zone were not widely separated in time.

The following is a list of species that have been obtained from the lower Miocene beds of Kern River, the San Juan area, and Los Vaqueros Valley.

	Los Vaqueros Valley	San Juan	Kern River
Echinodermata.			
Astrodapsis merriami Anderson	×	×	
Scutella norrisi Pack	×	×	
Pelecypoda.			
Arca osmonti Dall		×	×
Cardium quadrigenarium Conrad	×	×	
Cardium vaquerosense Arnold		×	
Cardium, sp.	×		
Chione conradiana Anderson		×	
Chione latilaminosa, new species			×
Chione mathewsonii Gabb	×	×	×
Chione panzana, new species		×	
Chione temblorensis Anderson		×	×
Corbicula dumblei Anderson			×
Cytherea diabloensis Anderson		×	×
Diplodonta buwaldana, new species			×
Diplodonta parilis Conrad	×		
Donax (?) triangulata, new species			×
Dosinia mathewsonii Gabb	×	×	×
Dosinia ponderosa Gray		?	×
Glycymeris branneri Arnold			×
Glycymeris, sp.			×
Leda ochsneri, new species			×
Macoma calcarea Gmelin			×
Macoma nasuta Conrad	×	×	×
Macoma ocoyana Conrad	×		×
Macoma piercei Arnold			×

	Los Vaqueros Valley	San Juan	Kern River
Pelecypoda.			
Mactra albaria Conrad			
Mactra catilliformis Conrad		×	×
Mactra sectoris, new species			×
Metis alta Conrad		×	×
Mytilus mathewsonii Gabb	×	×	×
Mytilus, sp.		×	×
Ostrea eldridgei Arnold	×		
Panopea estrellana Conrad		×	×
Pecten andersoni Arnold		×	×
Pecten branneri Arnold			×
Pecten magnolia Conrad	×		
Pecten nevadanus Conrad	×	×	?
Pecten peckhami Gabb			×
Pecten perrini Arnold			×
Pecten sespeënsis Arnold	×		×
Pecten vanvlecki Arnold		×	?
Pecten vaughani Arnold		×	
Phacoides acutilineatus Conrad	×	×	×
Phacoides richthofeni Gabb	×	×	×
Phacoides sanctaecrucis Arnold	×	×	×
Poromya gabbiana, new species		×	
Saxidomus nuttalli Conrad		×	×
Semele morani, new species		×	
Tellina nevadaënsis, new species		×	×
Tellina tenuistriata Davis		×	×
Tellina wilsoni, new species		×	
Transennella joaquinensis, new species			×
Venus pertenuis Gabb	×	×	×
Yoldia temblorensis, new species			×
Gastropoda.			
Agasoma barkerianum Cooper		×	×
Agasoma sanctacruzanum Arnold		×	×
Agasoma sinuatum Gabb	?		
Amphissa posunculensis, new species			×
Astyris pedroana Conrad		×	×
Bathytoma keepi Arnold		×	×
Bathytoma piercei Arnold		×	×
Cancellaria condoni Anderson		×	×
Cancellaria dalliana Anderson		×	×
Cancellaria joaquinensis Anderson		×	×
Cancellaria nevadaënsis, new species		×	×

	Los Vaqueros Valley	San Juan	Kern River
Gastropoda.			
Cancellaria pacifica Anderson		×	×
Cancellaria posunculensis, new species		×	×
Cancellaria sanjoseënsis, new species		×	×
Cancellaria simplex Anderson		×	×
Cerithium arnoldi, new species			×
Chrysodomus kernensis, new species			×
Conus hayesi Arnold		×	
Conus owenianus Anderson		×	×
Crepidula praerupta Conrad		×	×
Crepidula princeps Conrad		×	×
Cuma biplicata Gabb	?		
Dentalium petricolum Dall			×
Drillia antiselli, new species		×	
Drillia buwaldana, new species			×
Drillia howei, new species			×
Drillia kernensis, new species			×
Drillia ochsneri, new species			×
Drillia ocoyana, new species			×
Drillia temblorensis, new species			×
Drillia wilsoni, new species		×	
Epitonium posoënsis, new species			×
Epitonium williamsoni, new species			×
Eulimella californica, new species			×
Eulimella gabbiana, new species	?		
Eulimella ochsneri, new species			×
Ficus kernianus (Cooper)		×	×
Fossarus dalli, new species			×
Lacuna carpenteri, new species			×
Melongena sanjuanensis, new species		×	
Nassa arnoldi Anderson		×	×
Nassa antiselli, new species		×	×
Nassa blakei, new species			×
Nassa ocoyana, new species		×	×
Natica inezana Conrad (?)		×	×
Neverita callosa Gabb		×	×
Niso antiselli, new species		×	
Oliva californica Anderson		×	×
Oliva futheyana Anderson		×	×
Olivella pedroana Conrad		×	×
Pyramidella cooperi, new species			×
Scaphander jugularis Conrad		×	×
Sigaretus scopulosus Conrad	×	×	×
Siphonalia posoënsis, new species		×	

	Los Vaqueros Valley	San Juan	Kern River
Gastropoda.			
Thais vaquerosensis (Arnold)	×		
Terebra cooperi Anderson		×	×
Trochita costellata Conrad	×	×	×
Trophon gabbianum Anderson		×	×
Trophon kernensis Anderson		×	×
Turritella inezana Conrad	×		
Turritella ocoyana Conrad		×	×
Turritella variata Conrad		×	

Monterey Shale.—As in many other localities in the Coast Ranges of California, the Temblor group is overlaid along the San Juan River by a series of light colored organic shales with apparent, though probably not actual, conformity. The stratigraphic position and lithologic character of these beds make them conspicuous, and their strong lithologic contrast with the terriginous beds which they overlie makes the mapping of their contact comparatively simple. As there is no evidence, faunal or other, that they form a part of the underlying group, they have been referred to as the Monterey division of the Neocene. Their composition varies considerably within this district, though the predominating type of rock appears to be a mixture of siliceous, organic and bituminous shale, with terriginous clay shale and fine sand. The purely diatomaceous shale is much less prominent than in other areas where the Monterey group abounds. In the lower part of the group there is a large percentage of clay shale interstratified with siliceous, bituminous layers, while higher up organic materials are not prominent. In the northern part of Sec. 28, T. 28 S., R. 14 E., the lower part of the group consists to a large extent of light pumiceous rocks which are probably in part of volcanic origin. With this exception the Monterey rocks are largely a mixture of fine sandy clay and siliceous organic materials. The rocks of this type outcrop almost entirely across the San Juan district, in a zone parallel with the Temblor strata. To some extent and in some places they are covered by deposits of later age.

The Monterey group, as in all other localities where it occurs, is conspicuously unfossiliferous, except for the microscopic organisms which are of little value for correlation. The average thickness of the beds is between 600 and 1000 feet.

The Santa Margarita Group.—Overlying the Monterey group is a thick aggregate of strata consisting of gravelly sands, conglomerates, granitic sandstones and sandy clays that form a distinct group, lithologically. It is here classed as the Santa Margarita group, though perhaps the equivalent of the San Pablo of the Mount Diablo region. Although this group of strata appears to have a much greater thickness and to contain older beds than the Santa Margarita formation does in its type locality, for reasons which will be given later, it has been included entirely under this name. The Santa Margarita group, as well shown toward the southern part of the district, is unconformable upon the older groups, and although in some localities its relations are obscure, the evidence of unconformity is satisfactory in others.

The Santa Margarita group is the most prominent in the San Juan district on account of its thickness and great areal distribution. In the western part of the district it occurs as a long narrow zone parallel and adjacent to that of the Monterey shale. In the eastern part of the area the Santa Margarita outcrops in a rectangular zone which parallels and flanks San Juan River. If the covering of stream gravels and alluvium were removed from the surface, the Santa Margarita would be found to occupy nearly half of the San Juan district on the north and east.

At the base of the series there is a thin zone of soft, sandy clay shales which grade downward into the Monterey and upward into medium grained sandstone which is followed above by coarse arkosic sandstone and gravelly sands. The latter predominate throughout the formation, although there are numerous layers of soft sandy clays interstratified with the coarser sediments. East of the San Juan River, in the central part of T. 29 S., R. 17 E., the formation is composed almost entirely of coarse granitic material which is often so well cemented by the lime from fossil invertebrates that it stands out prominently on the hillsides in rugged outcrops.

A careful measurement of the thickness of these beds is difficult on account of numerous folds in the formation. The minimum thickness is estimated at 1500 feet and in many places it cannot be less than 2500 feet.

The correlation of these beds with the Santa Margarita formation need not depend alone upon the invertebrate fossils found in them. The character of the sediments and their stratigraphic position is almost as convincing as their fauna. A careful working out of the faunal zones in the Santa Margarita formation would doubtless enable us to correlate them with great accuracy as to detail. However, as this has not been possible in the present work the writers are not able to give an exact paleontological correlation of their various members. There is some stratigraphic evidence, however, that is worth consideration. The Santa Margarita in its type locality lies unconformably upon the Monterey group. This unconformity is marked by the presence of numerous angular fragments of Monterey shale in the basal beds and also, in some localities by a discordance in the attitude of the strata. In some parts of the San Juan district the Santa Margarita is apparently conformable upon the underlying Monterey, and the separation between the two is made largely upon the lithologic characters. In the Mount Diablo region the relations of the San Pablo formation to the underlying Contra Costa County Miocene, the middle and upper parts of which are probably the equivalent of the Monterey, while in some places obscure, and in general apparently conformable, there are nevertheless a few localities where there is evidence of unconformity. Further south in the Mount Diablo Range there is quite definite evidence in certain districts of unconformity between the Santa Margarita and Monterey Shale. On the eastward slopes of the Santa Lucia Range, west of the Salinas Valley, the Santa Margarita is certainly unconformable upon the Monterey in numerous localities.

It thus appears that during the deposition of the Santa Margarita vertical movements took place along the Santa Lucia Range, and probably likewise in the Mount Diablo Range, allowing a portion of the basin of deposition to be raised above sea level while the area now occupied by the San Juan district remained undisturbed and received continuous deposits. These

uplifts taking place at the close of Monterey time and continuing during the early part of Santa Margarita (San Pablo) time, followed by subsidence, resulted in the absence of the lower beds in the areas that were elevated. In the San Juan district where deposition was continuous the whole series is present, while along the eastern slope of the Santa Lucia Range only the middle and upper portion is represented. The character of the sediments and the comparatively small thickness of the beds at Santa Margarita agree in support of this explanation. In the region of Mount Diablo and Pinole, if the San Pablo is conformable upon the underlying beds, as it appears to be, we have the same condition that is here described, and the Santa Margarita of the San Juan district could be the equivalent of the San Pablo. The following species were obtained from the Santa Margarita of the San Juan district, and warrant the approximate correlation of these beds with both:—

Astrodapsis antiselli Conrad
Astrodapsis tumidus Remond
Astrodapsis whitneyi Remond
Chione, sp., *a*
Chione, sp., *b*
Macoma nasuta Conrad
Ostrea panzana Conrad
Ostrea titan Conrad
Phacoides, sp.
Pecten crassicardo Conrad
Pecten estrellanus Conrad
Pecten sancti-ludovici, n. sp.
Trophon carisaënsis Anderson
Turritella carrisaënsis, n. sp.
Tamiosoma gregaria Conrad

Etchegoin Group.—The occurrence of the Etchegoin group within the limits of the San Juan district has not been recognized, neither has it been disproved. A few miles to the east of the San Juan ranch house there are thick beds of clays, sands and gravels dipping to the westward that may in part belong to this group. In their physical appearance they are not unlike beds of Etchegoin age in the region of the Kettleman Hills. These beds of possible Etchegoin age are

December 30, 1914.

covered by well stratified beds of the following group in which freshwater shells have been found plentifully in certain localities.

Paso Robles Formation.—The Santa Margarita is overlaid unconformably by a series of gravelly sands and sandy clays that are, in part, at least a portion of the formation which is prominently developed in the Salinas Valley, and which has there been called by the name, Paso Robles formation, and has been supposed to be of freshwater origin.

The limits and distribution of this formation along the San Juan River are rather obscure, and it is difficult to separate it from the stream gravels and alluvium which is believed to be largely of Quaternary age. In the canyons east of the San Juan River, and dipping at a considerable angle westerly are sandstones and gravels with interstratified beds of clay which rest upon strata of possible Etchegoin age. These overlying strata contain numerous shells of freshwater mollusks. Among the species collected from these beds are

Lymnæa cubensis Lea,
Lymnæa, cf. obrussa Say,
Physa heterostropha Hald?, and
Planorbis, sp.

Along the northern and eastern parts of the district the Miocene is extensively covered by the Paso Robles formation which appears to have once extended entirely across the range in the vicinity of Polonia Pass, and to have been connected with similar beds in the Great Valley.

In former papers these Paso Robles beds have been correlated[1] with the Tulare group which is known to extend into the Antelope Valley on the west side of the Temblor Range.

Stream Gravels.—Overlying all of the older formations and groups from the basement rocks to the Paso Robles there are beds of stream gravels and alluvium widely spread over the entire district. These gravels mantle large areas of the Miocene in the central and eastern half of the San Juan district. They consist of pebbles of quartzite, sandstone, limestone, granite and basalt. They cover the Miocene rocks in all the higher portions of the eastern part of the district to a depth of from one foot to 200 or 300 feet. In general, the Miocene

[1] Proc. Calif. Acad. Sci., Vol. III, page 32.

rocks are exposed only where stream erosion has removed the mantle of gravels. These deposits were eroded from the higher portions of the San Jose Range by the agency of streams and laid down again upon the surface of the Miocene.

An unusual development of these gravels can be seen in the north-central part of T. 29 S., R. 16 E., and in the southern part of T. 28 S., R. 16 E., between Navajoa Creek and Cammattii Canyon. In viewing this region from a distance it appears as a nearly level tableland standing out in sharp contrast to the adjacent hills. Closer observation discloses numerous wide ravines cutting deeply into the apparently flat surface. The areas between these ravines are flat, producing the tableland appearance. The rock exposed in the beds of the ravines is gravel, indicating that the Miocene beds have been covered by them to the depth of the ravines themselves, which in some cases is more than 250 feet. In no locality between the Navajoa Creek and Cammattii Canyon do the Miocene beds outcrop. In the hills east of Navajoa Creek and also west of Cammattii Canyon, rocks of the Miocene group are exposed at elevations far above the beds of the ravines described above. The explanation of this peculiar condition is that the Navajoa Creek has in former time swung back and forth between Cammattii Canyon and its present position, removing all of the Miocene rocks to the depth at least of the present beds of the ravines. This removal of the Miocene rocks from the area probably took place during an epoch of uplift. When the region subsequently sank the flood plain of the Navajoa was aggraded and filled by stream gravels or alluvium at least to its present thickness. Whether these gravels represent remnants of the Paso Robles formation, or not, is a debatable question. In many localities they are associated with sands and clays which are also a part of the Paso Robles formation. In the southern part of the district there is a large area of gravels which is apparently due entirely to stream action. The gravels are distributed over the Miocene sediments almost as far back as the edge of the granite area of the San Jose Range. Along the northern and eastern parts of the San Juan district the Miocene is entirely covered by these gravels, which are in part Paso Robles.

Structure.—The structural features of the San Juan district are best explained and understood with respect to the topography, geology, and dynamic history of the surrounding ranges and of the region.

The district lying, as has been explained, between the San Jose Range on the southwest and the Temblor Range on the northeast, occupies a zone of low foot hills of younger strata intervening and bordering upon both. The dynamic agency that has effected the uplift of these ranges in earlier epochs has been regional and compressive, acting from southwest to northeast, in a direction at right angles to their trend. If at one effort or epoch it has elevated the main ranges, or initiated the main folds of the region, at later epochs it has developed the minor folds in the younger and more yielding strata lying between.

The final result of the thrust movement as expressed in the Tertiary strata along the San Juan River and throughout the district is the development of a number of local and discontinuous anticlines and synclines within the general area of the trough, which therefore might be called a synclinorium.

Along the southwest border of the sedimentary area the strata lie upon the granitic basement dipping away at angles between 10° and 30° toward the northeast.

In the Santa Margarita formation which is the only one exposed over a large part of the district, three or four sharp anticlinal folds have been formed having northwest and southeast axes, that continue longitudinally for limited distances and then plunge or disappear into local synclines with which they are in alignment. The dip on either side of the folds is often so steep as to approach the vertical, and the transverse shortening of the section from northeast to southwest must have been considerable. This area of intense folding extends for only a limited distance to the northwest toward the Salinas Valley, while to the southeast it may be followed toward the closely folded area of the Cuyama River and beyond.

Of the anticlines developed in this area the most conspicuous and persistent is that lying along the western border of the Carrizo Plains, extending from the north side of T. 30 S., R. 18 E., toward the northwest for 15 or more miles, disappearing in the northern part of T. 27 S., R. 16 E. This fold in-

volves all three members of the Miocene series. It is flanked on the southwest by some smaller folds of much less extent. Faulting has taken place along and parallel to several of the folds, but it is not prominent and needs no special consideration here.

The regional disturbances which have originated the foldings along the San Juan River have developed at the same time similar structures in many other districts within and probably without the Temblor basin, as described in the first part of this paper.

Economic Geology

The San Juan district is very largely devoted to stock raising and farming, and there are so far no industries based upon any mineral deposits. There are, however, some deposits of greater or less prospective merits and that may properly be described here.

Oil and Gas.—The San Juan district has been shown to contain a good development of the formations which are oil-bearing in other parts of the state and within the San Joaquin Valley, and to contain also some favorable structures, such as would appear attractive if located within the border of this valley.

Moreover, there are evidences of the escape of gases in the past from the formations exposed at different points along the San Juan River, and some slight signs of oil have been detected in wells sunk into the bituminous shales to the west of the river. These and other "indications" have induced some prospecting to be done for oil, and many have regarded its discovery in commercial quantities as a possibility, and this will not be denied.

However, the major folds in which oil could be stored have been dissected in such a manner by stream action, that if oil were present in large quantities it would be expected to make itself evident in oil saturations of the surface rocks, or in accumulations of asphaltum at the surface. No oil has yet been proved by actual drilling and wide areas on the flanks of the anticlines from which large deposits could be derived are not present. In other words the country available as a primary source of oil is quite restricted, and from this point of view, at least, commercial deposits do not appear likely.

Gold.—The only mineral of economic consequence that has been found in this district is gold. The stream gravels occurring along the canyons, especially on the Navajoa creek near the granite area, and along the small canyon one mile west of La Panza Post Office have been found to be gold bearing. During the period from 1880 to 1886 considerable interest was felt in these localities on account of the discovery of gold, and some placer mining was done along the stream beds but no large mines were developed. As a matter of history this district was known to contain gold before it was discovered by Marshall in 1848 at Coloma.

It is stated that over $1,000,000.00 in gold has been taken from these placers.[1] The De La Guerra gulch was the principal source of the gold.

Other Metals.—There are deposits and veins of other metals, as hematite and chromic iron, known in certain parts of the district, though they are perhaps not important.

On Section 25, Township 30 South, Range 17 East, there is an outcrop of iron gossan that can be followed for a distance of 1000 feet or more along the east side of the San Juan River. It appears to have a thickness of five to eight feet and to cut through an exposure of aplitic rock from north to south, with a steep westerly dip. It is not unlikely that this vein of gossan may mark the surface outcrop of a metalliferous vein other than iron. Exploration might reveal the presence of copper sulphides.

DESCRIPTIONS OF SPECIES.

ECHINODERMATA.

Genus ASTRODAPSIS Conrad

Astrodapsis peltoides, new species

Plate 2, figure 2

All of the specimens of this species are of moderate size, suboval or elliptical, moderately elevated, as in *Astrodapsis whitneyi* Remond; ambulacral areas bordered by shallow but distinct grooves, forming narrow ambulacral ridges and dis-

[1] 8th Rept. State Min. 1888, p. 530.

sected triangular interspaces; ambulacral ridges with slight grooved trough and distinct notch on the periphery.

Dimensions:—Length of the type specimen, 65 mm.; width, 55 mm.; altitude, 17 mm.

Occurrence:—This species occurs at various horizons in the Santa Margarita Formation of the Coalinga district, south of Waltham Creek. It is, however, most abundant in the Trophon zone, a little above the base of the Santa Margarita. This species does not appear to be related very closely to *A. whitneyi* Remond.

Type:—No. 102, Cal. Acad. Sci., Trophon zone, East of Jacalitos Creek, Coalinga, Fresno County, Cal., Lower Santa Margarita Beds. Collector, F. M. Anderson.

PELECYPODA

Genus LEDA Schumacher

Leda ochsneri, new species

Plate 3, figures 8a, 8b and 8c

Shell small, slightly arcuate anteriorly, excavated behind the beaks, rostrate and acute with valves closed at the posterior extremity; basal margin strongly and regularly arcuate, or sometimes slightly truncated at the rear; surface marked with strong concentric lines, polished; posterior ends bearing a shallow oblique groove extending downward from the beaks.

This shell resembles *Leda taphria* Dall, of which it may be the precursor, but it is relatively thicker, less elevated, and less clearly truncated behind.

Dimensions:—Length, 16 to 20 mm.; altitude, 9 to 10 mm.; thickness, 8 mm.

Occurrence:—Lower Miocene of Kern River, Kern County, California, at locality 68.

Type:—No. 103, and cotypes Nos. 104 and 105, Cal. Acad. Sci., on north bank of Kern River about ¾ mile west of the power plant and about 3 miles east of the Rio Bravo ranch house, Kern River, Kern County, California. Coll., J. P. Buwalda.

Named in honor of Mr. W. H. Ochsner.

Genus YOLDIA Möller

Yoldia temblorensis, new species

Plate 3, figure 3

Shell small, oblong ovate, thin, arcuate on lower margin, nearly straight above; beaks central, inconspicuous; hinge margin bent only six degrees from a straight line; anterior end well rounded; posterior end rostrate, almost pointed, slightly open, angulated by an impressed line extending from the beaks downward to the posterior end below the siphonal opening; anterior end similarly crossed by an impressed zone extending from the beaks obliquely downward and forward; surface sculptured by regular lines of growth.

Dimensions:—Length, 18 mm.; width, 7.5 mm.

Occurrence:—Lower Miocene of Kern River, California, locality 68.

Type:—No. 106, Cal. Acad. Sci., on north bank of Kern River about ¾ mile west of the power plant and about 3 miles east of the Rio Bravo ranch house, Kern County, California. Coll., J. P. Buwalda.

Yoldia newcombi, new species

Plate 3, figure 2

Shell small, thin, compressed, ovally elongated; valves equal, very inequilateral, greatly attenuated behind; beaks small, slightly raised, near the anterior extremity; escutcheon lanceolate, very long, bordered by a narrow groove; lunule indistinct; anterior dorsal margin short, nearly straight; anterior end well rounded; base ovately rounded; posterior extremity tapering to a narrow, rounded end, gaping; posterior dorsal margin broadly concave, with the opposed margins projecting above the escutcheon; posterior dorsal area flattened; umbones inconspicuous; interior inaccessible.

Dimensions:—Length, 14 mm.; length of rostrum, 10.5 mm.; altitude, 5 mm.; thickness of both valves, 2.2 mm.

Occurrence:—Lower Miocene of Clallam County, Washington, locality 213.

This species can be easily recognized by its small size and long rostrum.

Type:—No. 237, Cal. Acad. Sci., in sea-cliff ½ mile west of Twin Post Office, Clallam County, Washington. Coll., Bruce Martin.

Named in honor of Dr. C. F. Newcombe.

Genus PECTEN Müller

Pecten sancti-ludovici, new species

Plate 3, figures 10a and 10b

Shell of moderate size, equivalve, inequilateral, strongly ribbed, moderately inflated; umbones narrow and acute; each valve with nineteen or twenty ribs, rounded on the back and separated by narrow V-shaped interspaces; ribs ornamented by about six riblets forming fasciculi more or less beaded or roughened, not spiny; ears unequal, the anterior being nearly twice the length of the posterior, and on the right valve coarsely ribbed; posterior ear smaller and ornamented with wavy radial threads.

Dimensions:—Altitude of the type specimen, 40 mm.; width, 37 mm.; thickness, both valves, 19 mm.

This species differs from *Pecten hastatus* Sowerby, by having uniform riblets.

Type:—No. 107, and cotype No. 108, Cal. Acad. Sci., from the Santa Margarita formation along the west side of the San Juan River about one half mile above the mouth of Navajoa Creek, northeastern San Luis Obispo County, California. Coll., Bruce Martin.

Pecten etchegoini Anderson

Pecten etchegoini Anderson, Proc. Calif. Acad. Sciences, vol, 2, p. 198, pl. 18, figures 92-93, 1905.

Pecten (Chlamys) wattsi var. *morani* Arnold, U. S. G. S. Professional Paper No. 47, pp. 121-122, pl. 10, figs. 3, 4, 5, and 6, 1906.

Pecten (Chlamys) wattsi Arnold, var. *etchegoini* Anderson, U. S. G. S. Bull. 396, p. 77, 1909.

As the above named antedates the species and variety names proposed by Arnold, by at least a year, by the rules of precedence it should stand, and if there are varietal forms that merit distinct names these forms should be regarded as subspecies of *Pecten etchegoini* Anderson.

Genus POROMYA Forbes

Poromya gabbiana, new species

Plate 3, figures 7a and 7b

Shell of medium size, thin, convex, elongate, subquadrate, equivalve, inequilateral; beaks turned inward; umbones inconspicuous, a little anterior to the center; extremities well rounded; anterior dorsal margin slightly convex; posterior dorsal margin concave; base straight, parallel to the dorsal margin, contracted in the middle; surface sculptured with numerous fine concentric lines and small, almost invisible, radial striations, these crossed diagonally by low distant ridges that originate on the posterior dorsal margin, making a sharp convex bend toward the beaks, and then curving gradually downward toward the anterior ventral margin and disappearing on the dorsal area; there are fifteen of these ridges on the type specimen, and nearly twice that number on some of the cotypes; one cardinal tooth in each valve, the cardinal in the left valve diagonally elongate; ligament external; muscular impressions inaccessible.

Dimensions:—Length of the type, 46 mm.; altitude, 22.5 mm.; diameter of single valve, 8 mm.

Occurrence:—Lower Miocene of San Luis Obispo County, California, locality 126.

The living members of this genus are subtropical in habitat. None has been reported from the Miocene of California previous to this account.

Type:—No. 109, and cotype No. 110, Cal. Acad. Sci., in bed of a small creek near the center of Sec. 34, T. 28 S., R. 15 E., San Luis Obispo County, California. Coll., Bruce Martin.

Named in honor of Wm. Gabb.

Genus DIPLODONTA Bronn

Diplodonta buwaldana, new species

Plate 3, figures 1a and 1b

Shell small, thick, subcircular in outline, inflated; valves equal, inequilateral, slightly elevated in front of the beaks; beaks prominent, elevated, turned forward, slightly anterior to

the center; umbones full and broad; lunule indistinct; hinge line broadly arched; dorsal margins nearly straight in some specimens, slightly rounded in others; extremities well rounded, the posterior usually more broadly rounded than the anterior; basal margin circular; surface polished, marked by numerous fine concentric lines of growth; two teeth in each valve, the right posterior tooth faintly bifid; muscular impressions inaccessible.

Dimensions:—Length of one of the larger specimens, 21 mm.; altitude, 19 mm.; thickness of single valve, 7 mm.

Occurrence:—Not uncommon in the middle portion of the lower Miocene of Kern River, California, locality 65.

This species differs from *Diplodonta parilis* Conrad and *D. harfordi* Anderson by its inflated valves, much more prominent umbones, and more elevated beaks.

Type:—No. 111, and cotype No. 112, Cal. Acad. Sci., on west bank of a small canyon 1¼ miles northeast of Barker's ranch house, Kern County, California. Coll., Bruce Martin.

Named in honor of Mr. J. P. Buwalda.

Genus CARDIUM Linn.

Cardium weaveri, new species

Plate 1, figures 3a and 3b

Shell of medium size, rounded at the base, somewhat trigonal, inflated; umbones prominent, curved inward and forward; anterior dorsal slope short and slightly concave with a cordate area immediately in front of the beaks; posterior dorsal slope long and slightly convex making a rather sharp curve into the arcuate base; a conspicuous ridge from the beaks to the posterior ventral extremity, giving the valves an angulated appearance and forming a prominent posterior dorsal area in each valve; sculpture consisting of numerous equally spaced radial striations which are replaced on the posterior dorsal area by flattened radial ribs separated by narrow interspaces, the radial ribs becoming obsolete near the margin; about twenty radial ribs on the posterior dorsal area, and between fifty-five and sixty fine radial striations on the remainder of the surface; hinge, typical of the genus *Cardium*.

Dimensions:—Length of the type specimen, 50 mm.; altitude, 48 mm.; thickness, 38 mm.

Occurrence:—Lower Miocene, or possibly Oligocene, of northwestern Oregon and western Washington. The type was obtained from the bluffs at the west end of the railroad tunnel about three miles southeast of Timber, Oregon.

This species can be easily distinguished by its peculiar radial sculpture. A number of species of *Cardium* from the west coast of North America have less prominent sculpture on the posterior dorsal area than on the remainder of the surface. In this species the reverse is true.

Type:—No. 113, and cotype No. 114, Cal. Acad. Sci., from bluffs at the west end of the railroad tunnel about three miles southeast of Timber, Oregon. Coll., Bruce Martin.

Named in honor of Professor Charles E. Weaver, University of Washington.

Genus CHIONE

Chione panzana, new species

Plate 1, figures 1a and 1b

Shell large, heavy, subtriangular in outline; valves equal, inequilateral, convex, inflated; beaks elevated, turned inward and forward, about one-third the length of the shell from the anterior extremity; umbones full; lunule large, cordate, depressed, sculptured by numerous fine concentric lines, bordered by a narrow groove; escutcheon lanceolate, extending almost to the posterior extremity, crossed by the concentric sculpture; posterior dorsal slope arcuate; anterior dorsal margin strongly excavated in front of the beaks; extremities rather sharply rounded; base arcuate, crenulated within; surface marked by numerous strong, concentric ridges, somewhat irregularly spaced, and many small radiating ribs which are a little less conspicuous than the concentric ridges; hinge plate heavy, with three cardinal teeth, the middle one bifid.

Dimensions:—Length, 78 mm.; altitude, 69 mm.; thickness of single valve, 22 mm.

Occurrence:—Lower Miocene of northeastern San Luis Obispo County, California, the type from locality 53.

This species is related to *Chione securis* Shumard, but differs from it in having fainter crenulations, finer radial lines, curved dorsal border, and narrower escutcheon. It is also much less subtriangular in outline than the latter species. It differs from *Chione temblorensis* Anderson, in not having the angulated posterior ridge nor the prominent concentric ridges.

Type:—No. 115, and cotype No. 116, Cal. Acad. Sci., San Luis Obispo County, California, in a small creek about ¾ of a mile southwest of Lewis House, near the center of the S. E. ¼ of Sec. 22, T. 29 S., R. 16 E., Mt. D. B. L. and M. Coll., Bruce Martin.

Chione margaritana, new species

Plate 2, figure 1

Shell large, subelliptical, very inequilateral; valves equal, convex, inflated; beaks near the anterior margin, not elevated, turned forward; umbones full, narrow; lunule very large, sunken, concentrically striated, bordered by narrow groove; escutcheon broad and long, concentrically striated; posterior dorsal margin long, slightly arcuate; anterior margin strongly excavated in front of the beaks, rather sharply rounded near the base; basal margin broadly arcuate, crenulated within; posterior extremity evenly rounded; surface sculptured with numerous coarse, nearly equally spaced, radiating ribs and fine concentric striations which are irregularly raised, forming concentric ruffles; the radiating ribs absent on the posterior dorsal area; interior inaccessible.

Dimensions:—Length of the figured specimen, 108 mm.; altitude, 83 mm.; thickness of the right valve, 38 mm.

Type:—No. 117, Cal. Acad. Sci., from the top of the Santa Margarita beds in the N. E. ¼ of sec. 25, T. 21 S., R. 14 E. Uncommon in the Santa Margarita beds of the Coalinga region.

Chione (Lirophora) latilaminosa, new species

Plate 1, figures 2a, 2b and 2c

Shell small, trigonal, convex, depressed, very strongly characterized by prominent lamellæ; valves equal, inequilateral; beaks prominent, turned forward, near the anterior margin of the shell; basal margin semicircular, crenulated within; cardinal

margins nearly straight, meeting in almost a right angle; lunule distinct, bordered by an impressed line and marked with fine concentric striations; escutcheon large, lanceolate, sloping inward, the lamellæ stopping abruptly at its outer margin; surface ornamented with five or six very prominent reflexed concentric lamellæ, numerous fine concentric lines of growth, and fine radial striations which are hardly visible on some specimens; the concentric lamellæ are wavy and thin on the margins but thick at the base; hinge line angulated, with three cardinal teeth in each valve, the middle one usually bifid.

Dimensions:—Length of the type specimen, 15 mm.; altitude, 8 mm.; thickness of a single valve, 4.5 mm.

Occurrence:—Not uncommon in the middle portion of the lower Miocene of Kern River, California, locality 65.

Type:—No. 118, and cotypes Nos. 119 and 120, Cal. Acad. Sci., on west bank of a small canyon 1¼ miles northeast of Barker's ranch house, Kern County, California. Coll., Bruce Martin.

Genus TRANSENNELLA Dall

Transennella joaquinensis, new species

Plate 3, figures 6a, 6b and 6c

Shell small, solid, circular in outline; valves equal, inequilateral, convex; beaks elevated, turned forward a little anterior to the middle; umbones full; dorsal margin concave in front of the beaks, nearly straight behind; extremities well rounded; base arcuate; surface marked with numerous fine concentric lines; lunule cordate, bordered by an impressed line; hinge plate of the left valve with three cardinal teeth and one anterior lateral which is elongated diagonally; the middle cardinal not distinctly bifid; pallial sinus small and shallow.

Dimensions:—Length of the type specimen, 8 mm.; altitude, 7.5 mm.; thickness of the right valve, 2.5 mm.

Occurrence:—Not uncommon in the lower Miocene of Kern River, California, locality 65.

This species can be separated from *Transennella tantilla* Gould and *T. californica* Arnold, by its less elongated form, more elevated beaks, and more prominent umbones.

Type:—No. 120, and cotypes Nos 121 and 122, Cal. Acad. Sci., on west bank of a small canyon 1¼ miles northeast of Barker's ranch house, Kern County, California. Coll., Bruce Martin.

Genus TELLINA Linn

Tellina nevadensis, new species

Plate 2, figures 3a, 3b and 3c

Shell large for the genus, compressed, inequilateral, inequivalve; beaks prominent; anterior end evenly rounded; ventral margin broadly arcuate; posterior end rostrate and bent to the right, obliquely truncated; posterior dorsal margin straight from the beaks to the truncation; a prominent fold and a concave flexure extending from the umbones to the posterior ventral extremity and bordering the posterior dorsal area in either valve; right valve convex; left valve nearly flat; surface marked with concentric ridges corresponding to the lines of growth and fine radial lines which are invisible on worn specimens; hinge plate narrow, with two cardinal and two lateral teeth in the right valve, and two cardinal teeth in the left valve; the posterior cardinal in the right valve bifid; muscular impressions large and distinct; pallial sinus very deep, extending almost to the anterior adductor; a thickened obscure ray extending diagonally across the anterior portion of the shell behind the anterior adductor.

Dimensions:—Length of the type specimen, 54 mm.; altitude, 34 mm.; diameter of the right valve, 7 mm. The type consists of one perfect right valve which is accompanied by the left valve of a cotype. Length of the largest specimen, 75 mm.; altitude, 45 mm.; diameter, both valves, 11 mm.

Occurrence:—The type specimen was obtained from the lower Miocene of Kern River, California, locality 65. Other specimens were obtained from the same horizon in the northeastern part of San Luis Obispo County, locality 126.

This species resembles *Macoma nasuta* Conrad and *Macoma piercei* Arnold in general outline. It may be distinguished from these species by the lateral teeth in the right valve, the radial sculpture, and the prominent concave flexure on the posterior portion.

Type:—No. 124, and cotypes Nos. 125 and 126, Cal. Acad. Sci., in bed of small creek, near the center of Sec. 34, T. 28 S., R. 15 E., San Luis Obispo County, California. Coll., Bruce Martin.

Tellina wilsoni, new species

Plate 3, figures 11a and 11b.

Shell small, eight to ten millimeters in length, convex, moderately inflated; valves unequal, inequilateral; beaks conspicuous, within the posterior third; anterior dorsal margin long and straight, nearly parallel to the base; anterior extremity well-rounded; basal margin very slightly arcuate; posterior dorsal margin truncated, sloping sharply downward to the posterior extremity which is sharply rounded into the base; posterior end compressed, flexuous, curved to the right; surface marked by very fine concentric lines of growth which are usually invisible to the unaided eye.

Dimensions:—Length of the type specimen, 9 mm.; altitude, 6 mm.; thickness of the right valve, 2 mm.; thickness of both valves, 4½ mm.

Occurrence:—Not uncommon in the lower Miocene of San Luis Obispo County and of the Kern River region, California. The type specimen, No. 127, Cal. Acad. Sci., was obtained from locality 126.

Genus SEMELE Schum.

Semele morani, new species

Plate 3, figure 4.

Shell of moderate size, compressed, thin, subelliptical in outline; valves equal, convex, inequilateral, the anterior end slightly longer than the posterior; extremities well-rounded; ventral margin arcuate; beaks prominent, turned forward, excavated in front; anterior dorsal margin broadly convex; posterior dorsal margin nearly straight; lunule long and narrow, sunken, surface marked by numerous concentric lines of growth; a prominent flexure or furrow extending from the beaks to the posterior ventral margin; interior inaccessible.

Dimensions:—Length of the figured specimen, 25 mm.; altitude, 21 mm.; thickness of both valves, 8.5 mm.

Occurrence:—Uncommon in the lower Miocene of northeastern San Luis Obispo County, California, locality 126.

Type:—No. 129, Cal. Acad. Sci., in the bed of a small creek near the center of Sec. 34, T. 28 S., R. 15 E., San Luis Obispo County, California. Coll., Bruce Martin.

Named in honor of Mr. R. B. Moran.

Genus DONAX Linn.

Donax triangulata, new species

Plate 3, figure 9.

Valves small, thin, trigonal, convex; beaks a little anterior to the middle; dorsal margins nearly straight; anterior extremity rounded; basal margin nearly straight; posterior end sharply rounded; an umbonal angulation extending from the beaks to the anterior and posterior extremities, forming areas sculptured with six or seven radial ribs; left valve with one cardinal and two lateral teeth; ends crenulated within; muscular impressions indistinct.

Dimensions:—Altitude of the left valve, 5 mm.; length, 9 mm.; diameter of the left valve, 2 mm.

Occurrence:—Lower Miocene of Kern River, Kern County, California, locality 65.

Type:—No. 130, Cal. Acad. Sci., on west bank of a small canyon 1¼ miles northeast of Barker's ranch house, Kern County, California.

Genus MACTRA Linn.

Mactra sectoris, new species

Plate 3, figures 5a, 5b, 5c, 5d, and 5e.

Shell small, trigonal, equivalve, inequilateral, almost a quadrant of a spheno-discoidal solid; valves convex, inflated; beaks prominent, elevated, curved inward and forward; the forward dorsal margin slightly concave; posterior, slightly convex or straight; basal margin circular; ends sharply rounded, the anterior usually more so than the posterior; surface showing only

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concentric lines of growth which disappear on the earlier portions of the shell; a prominent ridge or angulation extending from the beaks diagonally to the posterior extremity; hinge typical of this genus; muscular impressions inaccessible.

Dimensions:—Altitude, 9 to 10 mm.; length, 10 to 13 mm.; thickness, 6 to 7 mm.

Occurrence:—Found abundantly in the lower Miocene of Kern River, California, locality 69.

Though much smaller in size, the shells of this species are almost exact prototypes of *Spisula exoleta* Gray as figured and described by Arnold, and as represented by a sample collected at San Diego. More than one hundred specimens of *M. sectoris* were obtained from the locality given above, and they were all nearly equal in size, there being no gradation between them and larger specimens. This fact seems sufficient to warrant its description as a new species.

Type:—No. 131, and cotype No. 132, Cal. Acad. Sci., on the south and west slopes of Pyramid Hills, about 15 miles northeast of Bakersfield.

GASTROPODA

Genus CALLIOSTOMA Swains.

Callistoma pacificum, new species

Plate 8, figures 2a and 2b.

Shell conical, thick, with about five convex whorls; spire moderately high; whorls of the spire ornamented with ten almost equally prominent spiral threads separated by narrower interspaces; two of the spiral threads nearest the posterior margin are centrally grooved; suture distinct, impressed; body-whorl slightly concave near the suture, convex over the central portion, sharply rounded at the base, sculptured the same as the whorls of the spire; the base ornamented with eighteen or twenty very fine spiral lines; aperture subcircular; outer lip smooth; columella thickened and incrusted.

Dimensions:—Altitude of the type specimen, 15 mm.; diameter of the last whorl, 14.5 mm.

Occurrence:—Miocene of the Oregon coast, five miles north of Yaquina Bay, locality 36.

This species is very similar to the recent and fossil species, *Calliostoma costatum* Martyn, but can be distinguished from the latter by the fine spiral sculpture on the base. The base of *C. costatum* is sculptured the same as the whorls of the spire.

Type:—No. 134, and cotype No. 133, Cal. Acad. Sci., one-half mile north of Yaquina Head, Lincoln County, Oregon.

Genus NISO Risso

Niso (?) antiselli, new species

Plate 7, figure 22.

Shell small, smooth, with six whorls; spire conical, upper whorls absent in the type specimen; whorls nearly flat, tapering toward the apex, unsculptured; suture appressed; body-whorl sharply angulated at the periphery; base convex, with a distinct umbilicus; aperture quadrate; outer lip distinctly angulated, angle about 100°; inner lip thin, smooth; umbilical opening large but not extending to the apex of the shell.

Dimensions:—Altitude, apex broken, 7.5 mm.; latitude of the last whorl, 4 mm.

Occurrence:—The type specimen was obtained from the lower Miocene of eastern San Luis Obispo County, California, locality 125.

The living species of this genus are found in tropical and temperate seas. The placing of this species in the genus *Niso* is somewhat doubtful. The umbilical opening does not extend to the apex of the shell; it is, however, much more pronounced than in any of the Eulimidæ or Pyramidellidæ and has therefore been classed as a *Niso*.

Type:—No. 135, Cal. Acad. Sci., on top of a hill in the southwest corner of the S. E. ¼ of Sec. 29, T. 28 S., R. 15 E., San Luis Obispo County, California.

Named in honor of Dr. Thomas Antisell, one of the early geologists of California.

Genus PYRAMIDELLA Lamarck

Pyramidella cooperi, new species

Plate 7, figures 18a and 18b

Shell small, turriculated, solid, with nine or ten whorls, apex acute; spire strongly elevated; whorls flatly convex, narrowly tabulated, sculptured with one prominent narrow groove at the front margin; body-whorl rather well rounded below, with short base; aperture subelliptical; outer lip semicircular, denticulated within; columella with one conspicuous posterior plication and two less prominent anterior plications.

Members of this genus inhabit tropical seas.

Dimensions:—Altitude of the type, 11 mm.; maximum latitude, 4 mm.

Occurrence:—From the lower Miocene of Kern River, California, locality 65.

Type:—No. 136, and cotype No. 137, Cal. Acad. Sci., on the west bank of a small canyon 1¼ miles northeast of Barker's ranch house, Kern County, California.

Named in honor of Dr. J. G. Cooper.

Genus EULIMELLA Fischer

Eulimella ochsneri, new species

Plate 7, figures 23a and 23b.

Shell small, elongated, slender, with eight or more whorls; spire high, with acute apex; whorls slightly convex, nearly flat, with narrow tabulation at the suture, ornamented with two or three very faint spiral lines near the base; the faint spiral lines at the base of the whorls are not visible on some specimens; suture distinct, channeled; aperture subquadrate; lips simple and smooth; body-whorl with a small umbilical chink.

Dimensions:—Altitude of the type, apex broken, 8 mm.; diameter of the last whorl, 3 mm.

Occurrence:—Not rare in the lower Miocene of Kern River, Kern County, California, locality 64.

Type:—No. 138, and cotype No. 139, Cal. Acad. Sci., in bottom of a small canyon about 1¼ miles due north of Barker's ranch house, Kern County, California.

Named in honor of Mr. W. H. Ochsner.

Eulimella dilleri, new species

Plate 7, figure 24.

Shell small, elongated, turriculated, solid, with eight to ten whorls; apex acute; whorls smooth, flatly convex; body-whorl sharply rounded below into a convex base; suture impressed, distinct; aperture subrectangular; inner lip reflexed; columella straight, without plications.

Dimensions:—Altitude of the figured specimen, apex broken, 9.5 mm.; maximum width of the shell, 3.5 mm.

Occurrence:—From the Miocene of the Oregon coast, four miles north of Yaquina Bay, locality 37.

This species differs from *Eulimella ochsneri* in having more convex whorls, an impressed suture instead of the appressed suture of the latter, and in being less convex at the periphery of the body-whorl.

Type:—No. 140, Cal. Acad. Sci., Lincoln County, Oregon, in the sea cliff ¼ mile north of lighthouse at Cape Foulweather.

Named in honor of Mr. J. S. Diller, Geologist, U. S. Geological Survey.

Eulimella californica, new species

Plate 7, figures 19a, 19b, and 19c.

Shell small, turriculated, elongated, smooth, solid, with seven or eight whorls; apex acute; whorls with a slight angulation near the anterior margin, flatly convex above, smooth; body-whorl convex at the base, nearly flat above; base not flattened; suture impressed; aperture elliptical; outer lip arcuate; inner lip concave, slightly incrusted.

Dimensions:—Altitude of the type specimen, 4.5 mm.; maximum latitude, 2 mm.

Occurrence:—Lower Miocene of Kern River, California, locality 64.

This species can be distinguished from *Eulimella ochsneri* and *E. dilleri* by its much smaller size, by the slight angulation on the anterior margin of the whorls, the lack of flattened base, and a more elliptically shaped aperture.

Type:—No. 141, and cotype No. 142, Cal. Acad. Sci., in the bottom of a small canyon about 1¼ miles due north of Barker's ranch house, Kern County, California.

Eulimella gabbiana, new species

Plate 7, figure 20.

Shell very small, slender and smooth, polished, with numerous whorls; apex acute (broken in the type specimen), whorls nearly flat, unsculptured; suture appressed, indistinct; base unflattened; aperture ovally elongated; outer lip sharply rounded anteriorly; inner lip concave, incrusted.

Dimensions:—Altitude of the figured specimen, upper whorls lost, 4 mm.; maximum width, 1.3 mm.

Occurrence:—Lower Miocene of Kern River, California, locality 64.

This species is distinguished by its small size, slender and smooth form, and its long narrow aperture.

Type:—No. 143, Cal. Acad. Sci., in the bottom of a small canyon about 1¼ miles due north of Barker's ranch house, Kern County, California.

Named in honor of Wm. Gabb.

Genus EPITONIUM Bolten

Epitonium posoënsis, new species

Plate 7, figure 10.

Shell conical, solid, with seven or eight whorls; spire elevated; whorls tabulated, nearly flat above, sculptured with twelve strongly raised varices, which are reflexed and broadened on top, and four or five spiral lines which are plainly visible between the varices; varices with prominent shoulders, giving the whorls a tabulated appearance; body-whorl squarely angulated at the base with a keel on the angle; base flat and smooth; aperture circular; outer lip thickened by the varix; inner lip incrusted, smooth.

Dimensions:—Altitude of the figured specimen, apex broken, 14 mm.; diameter of the last whorl, 8 mm.

Type:—No. 144, Cal. Acad. Sci., the lower Miocene of Kern River, California, locality 65.

Epitonium williamsoni, new species

Plate 7, figures 9a and 9b.

Shell long and narrow, with about ten whorls; spire very high; apex sharp; whorls convex, crossed by eighteen prom-

inent, rounded axial ribs extending from suture to suture; interspaces about equal in width to the ribs; the spiral sculpture consisting of small threads, about ten or twelve to each whorl, less prominent than the axial ribs; suture distinct, deeply channeled; two broad continuous varices diagonally crossing each whorl; body-whorl angulated at the base, the angulation carrying a carina; the base sculptured with spiral threads; aperture circular; outer lip thickened; inner lip incrusted, smooth.

Dimensions:—Altitude of the type specimen, apex defective, 18 mm.; maximum diameter of the body-whorl, 6.5 mm.

Occurrence:—From the lower Miocene of Kern River and eastern San Luis Obispo County, California.

This species is named in remembrance of Lieutenant R. S. Williamson who conducted the first exploring expedition to the rich district of Kern River and Poso Creek.

Type:—No. 145, and cotype No. 146, Cal. Acad. Sci., Kern County, California, on west bank of a small canyon 1¼ miles northeast of Barker's ranch house.

Genus LACUNA Turton

Lacuna carpenteri, new species

Plate 7, figure 21.

Shell small, thin, conical, with six flat tapering whorls; spire elevated; apex subacute; whorls smooth, flat or very slightly convex; suture distinct appressed; body-whorl large, angulated at the base; aperture ovate; outer lip thin; inner lip smooth, separated from the body-whorl by a small umbilical chink.

Dimensions:—Altitude of the figured specimen, 9 mm.; diameter of the last whorl, 5 mm.

Occurrence:—Lower Miocene of Kern River, California, locality 65.

Type:—No. 147, Cal. Acad. Sci., Kern County, California, on west bank of small canyon 1¼ miles northeast of Barker's ranch house.

Named in honor of Dr. Philip Carpenter.

Genus FOSSARUS Phil.

Fossarus dalli, new species

Plate 7, figures 13a and 13b.

Shell small, subglobose, solid, with three or four whorls which increase rather rapidly in size; spire short; whorls of the spire small, convex, sculptured with spiral threads separated by narrower interspaces, about six on the penultimate whorl; suture appressed; body-whorl more than three-fourths the total length of the shell, convex, globose, sculpture with fifteen spiral threads which are separated by narrower interspaces; aperture elliptical; outer lip arcuate; columellar margin excavated, smooth; a small umbilical chink visible on some specimens.

Dimensions:—Altitude of the type, apex and base broken, 5 mm.; latitude of the body-whorl, 3 mm.

Occurrence:—Lower Miocene of Kern River, locality 64.

The living members of this genus are most commonly found in tropical and temperate seas.

Type:—No. 148, and cotype No. 149, Cal. Acad. Sci., Kern County, California, in bottom of a small canyon about 1¼ miles due north of Barker's ranch house.

Named in honor of Dr. W. H. Dall.

Genus TURRITELLA Gray

Turritella carrisaënsis, new species

Plate 4, figure 4.

Shell solid, elongated, turrited, with about ten whorls; spire very high; whorls tabulated at the posterior third; tabulation flat and forming an angle of forty degrees with the axis of the shell; surface in front of the angle flat or slightly concave; ornamentation consisting of four spiral ridges, one prominent forming the angle, two about midway between the anterior margin and the angle, and the fourth, a sutural cord, on the anterior margin; the latter forming a slight angulation on the base of the last whorl; suture deeply impressed; aperture subquadrate.

Dimensions:—Altitude of the figured specimen, apex defective, 76 mm.; latitude of the last whorl, 29 mm.

Occurrence:—Not common in the middle portion of the Santa Margarita (San Pablo) formation in the eastern part of San Luis Obispo County, California, locality 58.

This species can be distinguished by its peculiar tabulation and spiral sculpture.

Type:—No. 150, Cal. Acad. Sci., San Luis Obispo County, California; in the south bank of a small creek in the N. E. ¼ of Sec. 22, T. 29 S., R. 17 E.

Genus CERITHIUM Brug.

Cerithium arnoldi, new species

Plate 7, figure 12.

Shell conical, elongate, small, with nine or ten closely appressed whorls; spire high; apex acute; whorls nearly flat, crossed by numerous irregular wavy, axial ribs which are rendered slightly nodose by the spiral cords; the spiral sculpture on the penultimate whorl consisting of three or four cords separated by wider interspaces which carry small secondary spiral threads; body-whorl carrying seven or eight of the larger spiral cords between each two of which there are three intercalary lines, the middle one slightly larger than the two on either side; base flattened producing a distinct angulation on the anterior portion of the body-whorl; aperture subquadrate; lips simple; canal very short.

Dimensions:—Altitude of the type, 19 mm.; diameter of the last whorl, 7.5 mm.

Occurrence:—A single specimen from the lower Miocene of Kern River, locality 64.

Type:—No. 151, Cal. Acad. Sci., Kern County, California, in the bottom of a small canyon about 1¼ miles due north of Barker's ranch house.

Named for Ralph Arnold in recognition of his valuable contributions to Tertiary paleontology.

Genus ARGOBUCCINUM Morch

Argobuccinum dilleri, new species

Plate 4, figure 7.

Shell large, solid, with nine or ten strongly sculptured whorls; spire high; whorls convex, tabulated, sculptured with

eighteen low, rounded axial ribs and numerous spiral cords which alternate in size; the spiral sculpture on the penultimate whorl consisting of four pair of double strap like cords, between each pair of which are three less prominent cords, the middle one being slightly larger than those on either side; the interspaces are narrower than the cords; the double cords produce nodulation on the axial ribs; two rugose discontinuous varices crossing each whorl from suture to suture; entire surface faintly spirally striate; canal and aperture partly defective.

Dimensions:—Altitude of the figured specimens, 65 mm.; maximum diameter of the body-whorl, 44 mm.

Occurrence:—From the Miocene of the Oregon coast, four and one half miles north of Yaquina Bay, locality 35.

This species can be distinguished from *Argobuccinum oregonense* Redfield by a difference in the spiral sculpture and more prominent varices.

Type:—No. 152, Cal. Acad. Sci., Lincoln County, Oregon, along the sea cliff a little south of the mouth of Wade Creek, about six miles north of Yaquina Bay.

Named in honor of Prof. J. S. Diller, Geologist, U. S. Geological Survey.

Genus AMPHISSA

Amphissa posunculensis, new species

Plate 7, figures 11a and 11b.

Shell small, thin, bucciniform, with about seven whorls; spire elevated; apex subacute; whorls well rounded and distinctly cancellated with small rounded axial ribs, separated by much wider interspaces and numerous spiral cords; the axial ribs are slightly nodose where crossed by the spiral cords; there are twenty-four axial ribs and about nine spiral cords of equal prominence on the penultimate whorl; the interspaces between the spiral lines usually carrying small intercalary threads; suture very distinct, channeled; body-whorl large with a broadly angulated base; aperture broadly elliptical; outer lip lirate within; inner lip incrusted; columella short, twisted; canal very short and broad, slightly curved.

Dimensions:—Altitude of the type, apex defective, 18 mm.; diameter of the last whorl, 9 mm.

Occurrence:—From the lower Miocene of Kern River, California, locality 65.

Type:—No. 153, and cotype No. 154, Cal. Acad. Sci., Kern County, California, on the west bank of a small canyon, $1\frac{1}{4}$ miles northeast of Barker's ranch house.

Genus AGASOMA Gabb

Agasoma columbianum, new species

Plate 5, figures 6a and 6b.

Shell large for the genus, conical above and below, revolute, tuberculated; spire high, having five or six conical whorls, sloping evenly to an acute apex; body-whorl angulated, carrying three rows of laterally elongated tubercules; the upper row most prominent and separated from the next row below by a concave surface; aperture ovate, broad in the middle, narrow before and extended into a moderately long recurved canal; outer lip thin and entire; inner lip incrusted; surface of the shell ornamented chiefly with revolving threads, three of which are prominent, forming the angles and elevated into tubercules; the spiral threads alternating in size and of three or four ranks, crossed at unequal intervals by sinuous lines of growth; suture broadened by thickened and wrinkled collar; canal wide and curved; the aperture is greater in length than the height of the spire.

Dimensions:—Altitude of the type specimen, 56 mm.; maximum width of the shell, 40 mm.; length of the aperture, 35 to 40 mm.

Occurrence:—Pittsburg Bluff, Nehalem River, and near Clatskanie, Oregon. This species is not uncommon in the Oligocene(?) of the Pittsburg horizon. It is not known in the rocks of the Astoria Group or in the older rocks below. It is usually associated with *Macrocallista pittsburgensis* Dall, *Molopophorus gabbi* Dall, and *Nucula shumardi* Dall.

Type:—No. 155, and cotype No. 156, Cal. Acad. Sci., Pittsburg Bluff, Nehalem River, Oregon.

Agasoma acuminatum, new species

Plate 5, figures 4a and 4b

Shell rather large, fusiform; spire elevated though shorter than the mouth, with five or six whorls; whorls angulated a

little below the middle, tuberculated on the angles, flattened and sloping regularly above, flattened below; suture distinct and bordered by a wrinkled collar which is ornamented with two or three spiral threads; aperture ovate, elongated into a long recurved canal; canal moderately wide; outer lip thin and simple, not lirate within; inner lip slightly incrusted; surface of the shell ornamented with numerous revolving threads of three alternating sizes, a few of which are coarser than the others, one or two bearing tubercules on the body-whorl.

Dimensions:—Altitude of the type specimen, 60 mm.; maximum latitude of the shell, 30 mm.

Found associated with *Diplodonta parilis* Conrad, *Nucula conradi* Dall, and *Tellina oregonensis* Conrad.

The ornamentation of this species is quite variable as regards the prominence of the tubercules. On some specimens they are pronounced while on others they are almost obsolete.

Type:—No. 157, and cotype No. 158, Cal. Acad. Sci., from the Oligocene(?) or possibly lower Miocene beds about ten miles northwest of Scappoose, Oregon, in Sec. 36, T. 4 N., R. 3 W.

Agasoma oregonense, new species

Plate 4, figures 3a and 3b

Shell of moderate size, fusiform; spire elevated, with seven or eight whorls; whorls angulated near the middle, flat or slightly convex above, cylindrical below, ornamented with numerous spiral threads of alternating magnitude, and irregularly raised axial lines of growth which are most pronounced on the upper whorls where they form nodes on the angulations; suture impressed; body-whorl large, ventricose, slightly constricted in front of the suture, with a rounded shoulder at the posterior third, concave above, convex below, sculptured similar to the whorls of the spire, but lacking the nodes on the shoulder; aperture ovate, outer lip simple, inner lip smooth; canal long and recurved.

Dimensions:—Altitude of the type specimen, 55 mm.; width of the body whorl, 27 mm.

Type:—No. 159, and cotype No. 160, Cal. Acad. Sci., from the Oligocene(?) or possibly lower Miocene, ten miles northwest of Scappoose, Oregon, locality 168.

Agasoma yaquinanum, new species

Plate 4, figures 5a and 5b

Shell pyriform, with five or six tabulated whorls; spire rather low; whorls angulated near the middle, flat above and below giving the shell a beautifully tabulated appearance, sculptured with eleven spiral threads, six above and five below the angle, and a large number of indistinct axial ribs which produce sharp nodulations on the larger spiral threads and especially on the angulations; body-whorl inflated, with a broad tabulation, sculptured with twelve or fourteen major spiral cords between which are three intercalary threads, the middle one of which is slightly larger than those on either side; the interspaces between these secondary spirals again occupied by very fine intercalary lines; axial ribbing almost obsolete on the body-whorl except on the angulation where they form nodes; suture appressed; aperture ovate; lips smooth and simple; canal moderately long and slightly recurved; columella twisted.

Dimensions:—Altitude of the type specimen, 25 mm.; maximum latitude of the shell, 14 mm.

Type:—No. 161, and cotype No. 162, Cal. Acad. Sci., Miocene of the Oregon coast, a little north of the entrance to Yaquina Bay, locality 39.

Genus NASSA Martini

Nassa ocoyana, new species

Plate 7, figure 17.

Shell small, with about five angulated whorls; spire elevated; whorls of the spire nearly flat, tabulated, sculptured with eight or nine broad, rounded axial ribs which are most prominent on the upper portion of the whorl where they produce nodes on the angulation, and seven or eight spiral cords which alternate in size, there being four or five slightly more prominent than those intervening; the axial ribs obsolete on the body-whorl and on the lower portion of the penultimate whorl; suture wavy, distinct, bounded below by a sutural band; body-whorl nearly flat at the center and marked by a strong spiral groove near the base; below the groove are three or four strong spiral threads and about eight indistinct spiral ridges between the groove and

the angulation; aperture elliptical, outer lip thickened by a varix; inner lip simple; canal short and recurved.

Dimensions:—Altitude of the figured specimen, canal defective, 11 mm.; diameter of the last whorl, 5 mm.

Occurrence:—Found in the lower Miocene of Kern River and eastern San Luis Obispo County, California.

Type:—No. 163, Cal. Acad. Sci., Kern County, California, in the bottom of a small creek 1¼ miles due north of Barker's ranch house.

Nassa blakei, new species

Plate 7, figures 15a and 15b.

Shell small, ovate, solid, with five or six whorls; spire elevated; whorls of the spire slightly convex, sculptured with four or five spiral lines, and twelve to fifteen raised axial ribs, most prominent at the middle of the whorls; the intersection of the axial ribs and the spiral lines producing small nodes; suture distinct, impressed; body-whorl large, about one half the total length of the shell, with prominent spiral ridges on the anterior and posterior margins, concave centrally, sculptured with numerous spiral lines and axial lines of growth; aperture subquadrate; outer lip thickened, denticulate within; inner lip incrusted, roughened; canal very short and broad.

Dimensions:—Altitude, 9 mm.; maximum width of the shell, 5 mm.; length of the aperture, including the canal, 4 mm.; width of the aperture, 2 mm.

Occurrence:—One specimen, the type, from the lower Miocene of Kern River, California, locality 65.

Type:—No. 164, Cal. Acad. Sci., Kern County, California, on the west bank of a small canyon 1¼ miles northeast of Barker's ranch house.

Named in honor of Mr. W. P. Blake.

Nassa antiselli, new species

Plate 7, figure 16.

Shell small, ovate; spire conical, elevated, with five nodose whorls; whorls slightly convex, tabulated, sculptured with three equally spaced spiral cords and about thirteen axial ribs which are equal in prominence to the spiral cords; the intersection of

the spiral and axial ribs producing conspicuous nodes; suture distinct, impressed; body-whorl ventricose, sculptured with eight spiral cords and fifteen axial ribs, nodose as the whorls of the spire; aperture elliptical; outer lip thickened by a conspicuous varix; inner lip smooth; columella short, with a small anterior sulcus; canal short and broad.

Dimensions:—Altitude, 8.5 mm.; diameter of the last whorl, 5 mm.

Occurrence:—Lower Miocene of San Luis Obispo County, California, locality 126.

This species can be distinguished by its small size, peculiar nodose sculpture, and prominent varix on the outer lip. It is more elongate and has much coarser sculpture than *Nassa arnoldi* Anderson.

Type:—No. 165, Cal. Acad. Sci., San Luis Obispo County, California, in the bed of a small creek near the center of Sec. 34, T. 28 S., R. 15 E.

Named in honor of Dr. Thomas Antisell.

Nassa lincolnensis, new species

Plate 7, figures 14a and 14b.

Shell small, globose, with four or five rather rapidly enlarging whorls; spire of medium height; apex blunt; whorls tabulated, convex, sculptured with three spiral bands between which are equal interspaces, and twelve axial ribs separated by wider interspaces; the intersection of the axial and spiral ribs producing nodes which are most prominent on the angle of the whorls; body-whorl convex, with sixteen axial ribs and eight flat topped spiral bands, the whole surface finely spirally striate; aperture ovate; outer lip simple; inner lip incrusted; columella very short with a distinct anterior sulcus.

Dimensions:—Altitude, 10 mm.; diameter of the last whorl, 6 mm.

Type:—No. 167, and cotype No. 168, Cal. Acad. Sci., Miocene of the Oregon coast, a short distance north of Yaquina Bay, locality 39.

Genus MOLOPOPHORUS Gabb

Molopophorus dalli, new species

Plate 6, figures 7a and 7b.

Shell moderate in size, stout, conical above, not strongly sculptured, with five whorls; spire rather high for the genus, tapering evenly except for the sutural collar; younger whorls ornamented with beaded collars, older whorls with beads obsolete; body-whorl with distinct constriction below collar; mouth ovate, narrowed above; outer lip thin and smooth; inner lip widely calloused; canal very short, wide, recurved; pillar partly encircled by strong plication which forms the outer border of the canal; surface marked by irregular axial ridges crossed by spiral cords.

Dimensions:—Length, 39 mm.; width, 25 mm.

Type:—No. 168, and cotype No. 169, Cal. Acad. Sci., from the Oligocene(?) near Clatskanie, Oregon, locality 165, in a prominent bluff along the county road about 2¼ miles southwest of Clatskanie.

Molopophorus gabbi Dall

Plate 6, figures 5a and 5b.

Molopophorus gabbi Dall, U. S. G. S. Professional Paper No. 59, 1909.

This species has been figured to illustrate the characters which distinguish it from *Molopophorus dalli.* As pointed out by Dr. Dall the form and sculpture of this species vary considerably, and it may be shown later that the form, here described as new, is only a wide variation of *Molopophorus gabbi* Dall. At present there seems to be sufficient difference in form and sculpture to separate the two as distinct species.

Genus CHRYSODOMUS Swains.

Chrysodomus kernensis, new species

Plate 4, figures 6a and 6b.

Shell of moderate size, solid, with seven whorls, nucleus lost on the type; spire high; apex subacute; whorls with well rounded shoulder near the middle, slightly rounded below, flat or concave above, rather strongly constricted in front of the

suture forming a distinct sutural collar, sculptured with numerous spiral cords having narrower interspaces; the width of the cords and the interspaces varying considerably, on the anterior portion and just above the shoulder of the body-whorl the cords alternating large and small; in the middle portion nearly equal, with one broad spiral band at the shoulder; the axial sculpture consisting of inconspicuous lines of growth; suture strongly appressed; body-whorl large, about two thirds the total length of the shell; aperture elliptical, outer lip ribbed within, inner lip smooth, calloused; canal short, wide, recurved; columella twisted, with small anterior sulcus.

Dimensions:—Altitude of the type, apex defective, 62 mm.; maximum latitude of the shell, 28 mm.; length of the aperture, including the canal, 31 mm.; width of the aperture, 12 mm.

Occurrence:—Lower Miocene of Kern River and eastern San Luis Obispo County, California. The type was obtained from locality 65.

Type:—No. 172, and cotype No. 173, Cal. Acad. Sci., Kern County, California; on west bank of a small canyon 1¼ miles northeast of Barker's ranch house.

Genus SIPHONALIA Adams

Siphonalia posoënsis, new species

Plate 4, figure 2.

Shell large, fusiform, solid, with seven or more whorls; spire high, conical; whorls angulated near the anterior margin, the angulation ornamented with about nine prominent nodes; surface above the angulation nearly flat or concave; sculpture consisting of spiral grooves and axial lines of growth; the spiral grooves somewhat irregularly spaced and the spaces between them often raised forming spiral cords; body-whorl angulated near the middle, concave above, convex below; aperture ovate; outer lip arcuate; inner lip smooth, incrusted; canal moderately long, curved to the left; columella incrusted, with a long anterior sulcus.

Dimensions:—Altitude, 90 mm.; maximum latitude of the last whorl, 45 mm.; length of the aperture, including the canal, 43 mm.; width of the aperture, 17 mm.

December 30, 1914.

Type:—No. 174, Cal. Acad. Sci., lower Miocene of San Luis Obispo County, California, locality 126, in the bed of a small creek near the center of Sec. 34, T. 28 S., R. 15 E.

Genus MELONGENA Schum.

Melongena californica, new species

Plate 4, figure 1

Shell of moderate size solid, pyriform, with a low spire; whorls of the spire inconspicuous, unsculptured, three or four in number; body-whorl inflated, broadest near the posterior margin, the middle and anterior portion sloping downward to the canal; ornamentation consisting of two rows of nodes; one on the shoulder, and the other a little anterior to the middle, the nodes are pronounced and number about five to a row; aperture oval, inner lip smooth incrusted; columella broad and heavy, with prominent anterior sulcus; canal defective, probably broad and nearly straight.

Dimensions:—Altitude, canal defective, 38 mm.; width of the last whorl, 29 mm.; length of the aperture, including a portion of the canal, about 30 mm.

Type:—No. 175, Cal. Acad. Sci., lower Miocene of eastern San Luis Obispo County, California, locality 60, on the top of a prominent ridge one mile east of the San Juan River in the N. W. cor. of the N. E. ¼, Sec. 3, T. 30 S., R. 17 E.

This genus has not previously been reported to occur in the Miocene of California.

Genus TROPHON Montf.

Trophon oregonensis, new species

Plate 5, figure 5

Shell large, thick, fusiform, with six or seven angulated whorls; spire elevated; whorls of the spire angulated near the middle, surface flat and smooth above, smooth and sloping inward below; whorls ornamented with nine or ten prominent projecting spines which are excavated in front and convex behind and extending downward to the suture in front forming short varices; suture impressed, wavy; body-whorl ventricose,

sharply concave at the anterior margin; aperture ovate; canal moderately long, slightly twisted.

Dimensions:—Altitude of the figured specimen, 58 mm.; maximum diameter of the last whorl, 40 mm.

Type:—No. 176, Cal. Acad. Sci., Miocene of the Oregon coast, four miles north of Yaquina Bay, locality 38.

Trophon kernensis has a lower spire, angulation of the whorls more anterior, and with nodes instead of excavated spines. *Trophon carisaënsis* Anderson, has a smaller number of spines, angulation nearer the anterior margin, and a shorter and much more thickened columella. *Trophon gabbianus* Anderson, is a closely allied species with less prominent spines and ornamented with many revolving cords and grooves on the body-whorl below the shoulder.

Trophon gabbianus Anderson

Plate 5, figure 1.

Trophon gabbiana Anderson, Proc. Calif. Acad. Sci., 3rd Series, Geology, vol. 3, No. 2, page 203, Pl. 16, fig. 79-80.

This species is refigured in order to point out more clearly the distinguishing characters of *Trophon oregonensis*, new species.

Genus THAIS Bolten

Thais trophonoides, new species

Plate 6, figures 1a and 1b.

Shell of moderate size, globose, solid, with five rather rapidly enlarging whorls; spire moderately elevated; apex blunt; whorls of the spire angulated a little below the middle, flat above and below, crossed by nine axial ribs and seven or eight spiral cords; axial ribs most prominent on the angle of the whorl; interspaces between the spiral cords usually occupied by a small intercalary thread; suture appressed; body-whorl large, ventricose, angulated above the middle, marked by nine axial ribs which are obsolete on the anterior portion, and numerous spiral cords between which are intercalary threads; aperture pyriform; outer lip angulated above and below the middle; columella twisted, with narrow groove and a deep anterior sulcus; canal recurved.

Dimensions:—Altitude of the type specimen, 34 mm.; maximum width of the shell, 24 mm.

Type:—No. 178, and cotype No. 179, Cal. Acad. Sci., from the lower Miocene of Kern River, locality 65, on the west bank of a small canyon 1¼ miles northeast of Barker's ranch house.

Thais blakei, new species

Plate 6, figures 4a and 4b.

Shell solid, fusiform, with six whorls; spire moderately high; whorls of the spire with a well rounded angle near the anterior margin, flat or concave above, restricted near the suture, sculptured with spiral cords and coarse, raised, axial lines of growth; seven or eight spiral cords on the penultimate whorl, separated by wider interspaces which occasionally carry a fine intercalary thread; suture appressed; body-whorl with a well rounded shoulder a little in front of the suture, concave above, inflated below, sculptured in the same manner as the whorls of the spire; aperture ovate, outer lip thickened, denticulate within, inner lip smooth, incrusted; canal short, recurved; columella twisted, with anterior sulcus.

Dimensions:—Altitude of the type, apex defective, 34 mm.; maximum latitude of the shell, 17 mm.; length of the aperture, including the canal, 21 mm.; width of the aperture, 6 mm.

Type:—No. 180, and cotype No. 181, Cal. Acad. Sci., lower Miocene of Kern River, California, locality 65, on the west bank of a small canyon 1¼ miles northeast of Barker's ranch house.

Thais blakei resembles *Thais edmondi* Arnold in general form. It may be distinguished from the latter by its uniformly larger size, longer canal, and the lack of nodes on the shoulder or angle of the whorls.

Thais panzana, new species

Plate 6, figure 6.

Shell solid, of moderate size; whorls five or six; spire elevated, conical; suture distinct, channeled; whorls of the spire conical, slightly concave above the middle, with a row of nodes around the anterior margin giving them an angular appear-

ance, sculptured with distinct spiral cords separated by narrower interspaces, eleven or twelve on the penultimate whorl; body-whorl large, about two-thirds the total length of the shell, angulated near the middle, concave above, almost flat below and narrowing rapidly to the canal, with eight prominent nodes on the angulation, eight spiral cords above the shoulder and about eighteen below; aperture elliptical, outer lip angulated, inner lip smooth; columella stout, incrusted, with anterior sulcus; canal short, recurved.

Dimensions:—Altitude of the figured specimen, apex defective, 30 mm.; maximum latitude of the shell, 16 mm.; length of the aperture, including the canal, 20 mm.; width of the aperture, 8 mm.

Type:—No. 182, Cal. Acad. Sci., lower Miocene of eastern San Luis Obispo County, California, locality 126, in the bed of a small creek near the center of Sec. 34, T. 28 S., R. 15 E.

Thais nehalemensis, new species

Plate 6, figure 3.

Shell solid, fusiform, with about six whorls; spire moderately elevated; apex acute; whorls of the spire concave with a raised anterior margin or collar which is ornamented with twelve to fourteen prominent nodes, the nodes partly obscured by the overlapping of the succeeding whorl; concave area smooth or marked by very fine spiral lines; suture indistinct due to the overlapping of the whorls; body-whorl large, more than three-fourths the total length of the shell, angulated near the middle, concave above, ornamented with thirteen prominent nodes and numerous revolving threads of three or more ranks which alternate regularly; nodes most prominent at the angle, fading out above and on the anterior portion of the whorl; the spiral threads most prominent on the nodose area; aperture oval, outer lip simple, inner lip incrusted, smooth; posterior sinus broad and shallow; canal short and broad, recurved.

Dimensions:—Length of the shell, 33 mm.; maximum diameter of the body-whorl, 19 mm.; length of the aperture and canal, 21 mm.; width of the aperture, 8 mm.

Type:—No. 183, Cal. Acad. Sci., Oligocene or lower Miocene beds ten miles northwest of Scappoose, Columbia County, Oregon.

The presence of the posterior sinus in this species indicates that it might be more properly placed in the *Pleurotomidæ,* but the short and broad canal and general shape of the shell suggest the genus *Thais* to which it has been assigned temporarily.

Genus FUSINUS Rafinesque

Fusinus empireënsis, new species

Plate 5, figure 7.

Shell solid, fusiform, with eight or nine convex whorls; spire elevated; whorls moderately convex, sculptured with seven or eight coarse rounded spiral cords alternating in prominence, the cords on the anterior portion slightly more elevated than those on the posterior, frequently giving the whorls an angulated appearance; body-whorl with eighteen spiral cords, axial sculpture consisting of lines of growth; suture distinct, channeled; aperture rounded or circular; inner lip smooth, lightly incrusted; canal defective in the type, probably of moderate length.

Dimensions:—Altitude, 50 mm.; canal defective; latitude of the last whorl, 23 mm.

Type:—No. 185, Cal. Acad. Sci., from the Empire formation, Miocene of Coos Bay, Oregon, locality 1, in the sandstone exposed on the east shore of Coos Bay, opposite Coos Bay Bar, 100 yards north of the S. W. cor., Sec. 30, T. 25 S., R. 13 W.

Genus CANCELLARIA

Cancellaria lickana, new species

Plate 8, figures 6a, 6b, 6c, and 6d.

Shell globose, solid, with five or six rapidly enlarging whorls; spire low; whorls of the spire small, inconspicuous, convex, sculptured with four or five spiral threads with nearly equal interspaces which carry a fine intercalary thread; suture appressed; body-whorl large, globose, sculptured with about twenty spiral cords and an equal number of intercalary threads; axial sculpture consisting of lines of growth; aperture elliptical; outer lip crenulated; inner lip with heavy callus covering a portion of the body-whorl; canal very short, broad, straight; columella with two plications and an anterior sulcus.

Dimensions:—Altitude of the type, 21.5 mm.; latitude of the last whorl, 16 mm.; length of the aperture, 17 mm.; width of the aperture, 6.5 mm.

Type:—No. 186, and cotypes Nos. 187, 188, 189, Cal. Acad. Sci., lower Miocene of Kern River, California, locality 65, on the west bank of a small canyon 1¼ miles northeast of Barker's ranch house.

This species resembles superficially the figures of *Purpura lima* Martyn, published in an earlier paper[1] and referred to by Ralph Arnold in his description of *Cancellaria andersoni.* The species here described differs from *Cancellaria andersoni* Arnold, in not having axial ribbing on any of the whorls, while it shows strong spiral sculpture on all of them. The surface of the body-whorl is not inornate, but is crossed by strong spiral threads and distinct lines of growth which give the surface a doubtfully cancellated appearance.

Cancellaria nevadensis, new species

Plate 8, figures 5a, 5b, 5c, and 5d.

Shell small, solid, ovate, with five or six tabulated whorls; spire moderately high; apex subacute; whorls angulated above the middle, flat or slightly concave above, convex below, sculptured with numerous spiral threads and irregular axial ribs; the interspaces between the spiral threads vary in width and frequently carry intercalary threads; axial ribs most prominent on the whorls of the spire where they form small nodes on the angulations, almost obsolete on the body-whorl of most specimens; suture distinct, impressed; aperture ovate; outer lip thin; canal short and wide; columella with two plications and a small anterior sulcus.

Dimensions:—Altitude of the type, 18 mm.; maximum latitude of the shell, 10 mm.; length of the aperture, 11 mm.; width of the aperture, 4 mm.

Type:—No. 190, and cotypes Nos. 191, 192, 193, Cal. Acad. Sci., lower Miocene of Kern River, California, locality 68, on the north bank of Kern River about ¾ mile west of the power plant and about 3 miles east of the Rio Bravo ranch house.

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[1] Proc. Calif. Acad. Sci., 3rd Ser., vol. 2, p. 202, pl. 15.

Cancellaria condoni Anderson

Plate 8, figures 8a, 8b, 8c, and 8d.

Cancellaria condoni Anderson, Proc. Calif. Acad. Sci., 3rd Series, Geol., Vol. 2, p. 200, pl. 15, fig. 49-50, 1905.

This species is refigured here in order to illustrate its variations and to point out more clearly the characters by which it may be distinguished from the new species of *Cancellaria* that are here described.

Cancellaria dalliana Anderson

Plate 8, figures 1a, 1b, 1c, and 1d.

Cancellaria dalliana Anderson, Proc. Calif. Acad. Sci., 3rd Ser., Geol., Vol. 2, p. 199, pl. 15, fig. 39-40, 1905.

Refigured with *Cancellaria condoni* Anderson, see above.

Cancellaria posunculensis, new species

Plate 8, figures 7a, 7b, and 7c.

Shell small, ovate-elongate, with six whorls; spire high; whorls convex, sculptured with about eight spiral threads which are separated by narrower interspaces carrying intercalary lines; axial sculpture consisting of close-set lines of growth, much less pronounced than the spiral threads; the intersection of the axial and the revolving lines producing a delicately cancellated surface; suture distinct, impressed, bordered anteriorly by a small tabulation; body-whorl large, about three-fourths the total length of the shell, gracefully convex, ornamented with eighteen major spiral threads between which are smaller intercalary lines; axial sculpture same as on the whorls of the spire; aperture elliptical; outer lip arcuate, denticulate within; canal short, curved; columella long and recurved, carrying three plications, two of them slightly larger than the third.

Dimensions:—Altitude of the type, 17.5 mm.; maximum diameter of the body-whorl, 8 mm.; length of the aperture, including the canal, 10 mm.

Type:—No. 202, and cotypes Nos. 203 and 204, Cal. Acad. Sci., lower Miocene of Kern River, California, locality 65, on the west bank of a small canyon, 1¼ miles northeast of Barker's ranch house.

Cancellaria rotunda, new species

Plate 8, figures 4a and 4b.

Shell globose, thin, with five well rounded whorls; spire rather short; apex blunt; whorls of the spire convex, ornamented with thirteen prominent rounded axial ribs with wider interspaces, and five or six spiral threads with very small intercalary lines; suture depressed; body-whorl comprising the greater portion of the shell, evenly globose, sculptured the same as the whorls of the spire, with thirteen axial ribs and sixteen spiral threads; the axial ribs much more pronounced than the spiral threads; the interspaces between the spiral threads carrying intercalary lines; aperture semicircular; outer lip thickened; inner lip incrusted; canal short; columella with two plications on the anterior portion.

Dimensions:—Altitude of the type, 14 mm.; maximum latitude of the shell, 12 mm.; altitude of an entire specimen, about 21 mm.

Type:—No. 205, and cotype No. 206, Cal. Acad. Sci., Miocene of the Oregon coast, a half mile north of Yaquina Bay, locality 39.

Cancellaria sanjosei, new species

Plate 6, figures 2a and 2b.

Shell small, ovate, thick, with five or six rather rapidly enlarging whorls; spire elevated; whorls slightly convex or flat, with a narrow tabulation, sculptured with seven or eight flat spiral cords, the alternate cords being slightly more prominent than those adjacent; suture distinct; body-whorl large, about five-sixths of the total length of the shell, tabulated above, sculptured with fourteen major spiral cords with alternate small intercalary threads; aperture elongate-oval, outer lip thick, columella with two plications and an anterior sulcus; canal short.

Dimensions:—Altitude of the type specimen, 20 mm.; diameter of the body-whorl, 11.5 mm.

Type:—No. 207, and cotypes No. 208, Cal. Acad. Sci., lower Miocene of eastern San Luis Obispo County, California, locality 126, in the bed of a small creek near the center of Sec. 34, T. 28 S., R. 15 E.

Genus ADMETE

Admete clatskaniënsis, new species

Plate 8, figures 3a and 3b.

Shell small, ovate, thin, with six tabulated whorls, nucleus excluded; spire high, with an acute apex; whorls angulated at the middle, flat above, convex below, sculpture consisting of twelve broad, rounded axial ribs which are most prominent on the angle where they are slightly nodose, becoming obscure near the suture and on the anterior portion of the body-whorl, crossed by ten spiral threads on the penultimate whorl, four above the angle and six below, the latter alternating in prominence; suture distinct, channeled; body-whorl convex, with fifteen spiral threads which alternate in size, the interspaces on the anterior portion containing a small intercalary thread; aperture oval; outer lip arcuate; canal short; columella with two small plications and a small anterior sulcus.

Dimensions:—Altitude of the type specimen, 10 mm.; maximum diameter of the last whorl, 5 mm.

Type:—No. 209, and cotype No. 210, Cal. Acad. Sci., Oligocene(?) (or Miocene) of Columbia County, Oregon, two and one-half miles southwest of Clatskanie.

Genus TURRIS Bolten

Turris lincolnensis, new species

Plate 6, figure 8.

Shell large, fusiform, with seven or eight whorls; spire high, with an acute apex; whorls of the spire obtusely angulated a little anterior to the middle, nearly flat above and below, slightly concave near the suture; ornamentation consisting of prominent nodes and fine spiral threads separated by wider interspaces carrying fine intercalary lines, fifteen nodes and about twenty-four major spiral threads on the penultimate whorl; suture distinct, appressed; body-whorl ventricose, ornamented with a row of nodes a little above the middle producing a slight angular appearance, convex above and below, constricted at the suture; spiral sculpture similar to that of the whorls of the spire; aperture oval, with a broad and shallow posterior sinus; canal moderately long.

Dimensions:—Altitude of the figured specimen, apex and canal defective, 43 mm.; width of the last whorl, 24 mm.

Type:—No. 211, Cal. Acad. Sci., Miocene of the Oregon coast, five miles north of Yaquina Bay, locality 36.

This species is near *Turris coli* Dall, which has the nodes extending to the suture above and is not distinctly angulated. The new form has nodes instead of ribs, and is angulated.

Turris carlsoni, new species

Plate 5, figures 2a and 2b.

Shell large and solid, fusiform, with about eight whorls; spire high, with an acute apex; whorls of the spire with a subdued angular appearance below the middle, slightly concave above, convex below, ornamented with a row of nodes on the angulation, and numerous spiral striations somewhat alternating in prominence; suture appressed, bordered by a sutural collar; body-whorl ventricose, convex near the middle of the whorl, with inconspicuous or obsolete nodes, spiral sculpture the same as on the upper whorls; on some specimens the lower portion of the body-whorl is marked by raised spiral cords and intercalary lines in place of the incised lines or striations; aperture oval, with a simple outer lip; columella incrusted, smooth, with an anterior sulcus; canal moderately long, curved to the left.

Dimensions:—Altitude of the type specimen, canal defective, 44 mm.; width of the last whorl, 21 mm.; length of the aperture, including the canal, 25 mm.

Type:—No. 212, and cotype No. 213, Cal. Acad. Sci., Miocene of the Oregon coast, six miles north of Yaquina Bay, locality 36.

Named for John I. Carlson of the California Academy of Sciences.

Genus BATHYTOMA Harris & Burrows

Bathytoma condonana, new species

Plate 7, figure 8.

Shell of moderate size, ovate, with elevated spire and acute apex; whorls six or seven, ornamented with a row of nodes near the anterior margin, concave above, finely cancellated with

numerous spiral threads and fine axial ribs; the penultimate whorl carrying twelve nodes on the angulation; suture distinct, strongly appressed; body-whorl large, ventricose, angulated above the middle, concave above, convex below, marked in front of the angle with numerous raised spiral ridges with wider interspaces carrying small intercalary threads.

Dimensions:—Altitude of the figured specimen, 16.5 mm.; diameter of the body-whorl, 9.5 mm.

Type:—No. 214, Cal. Acad. Sci., lower Miocene of the Oregon coast, four miles north of Yaquina Bay, locality 39.

Named in honor of the late Professor Thos. Condon, University of Oregon.

Genus DRILLIA Gray

Drillia ochsneri, new species

Plate 6, figures 9a, 9b, and 9c.

Shell large, fusiform, with high spire and acute apex; whorls eight or nine, angulated a little below the middle, concave above, flat or convex below, crossed by ten or eleven low axial ridges most prominent on the shoulders where they form nodes, but disappearing above the shoulder on the whorls of the spire and on the anterior portion of the body-whorl; spiral sculpture consisting of revolving threads which occur only on the anterior portion of each whorl; nodes obsolete on the body-whorl of some specimens; suture distinct; aperture narrowly elliptical, with a deep posterior sinus between the shoulder and the suture; columella smooth and twisted; canal moderately short and curved.

Dimensions:—Altitude of the type specimen, 43 mm.; diameter of the last whorl, 20 mm.; length of the aperture including the canal, 22 mm.

Type:—No. 215, and cotypes Nos. 216, 217, Cal. Acad. Sci., lower Miocene of Kern River, California, locality 65, on the west bank of a small canyon 1¼ miles northeast of Barker's ranch house.

This species has been referred to in a few cases as *Drillia johnsoni* Arnold. It differs from the latter in the following respects: angulation of the whorls more anterior, nodes and

axial ribbing more pronounced and of a different character, and the shell broader in proportion to the altitude.

Named in honor of Mr. W. H. Ochsner.

Drillia wilsoni, new species

Plate 6, figures 10a, 10b, and 10c.

Shell large for the genus, elongated, solid, with eight or nine whorls; spire elevated; whorls sharply angulated at the middle, very concave above, flat or slightly convex above, crossed by ten rounded, oblique axial ridges rising to prominent nodes on the angles, becoming fainter or disappearing immediately above; the axial ridges crossed by spiral cords separated by grooved interspaces in front of the shoulder on each whorl, four or five on the penultimate whorl, and eighteen or twenty on the last whorl; aperture ovate; columella smooth, straight; canal moderately long, nearly straight.

Dimensions:—Altitude of the type, with defective apex, 47 mm.; diameter of the last whorl, 18 mm.; length of the aperture, including the canal, 23 mm.

Type:—No. 218, and cotypes Nos. 219, 220, Cal. Acad. Sci., lower Miocene of eastern San Luis Obispo County, California, locality 126, in the bed of a small creek near the center of Sec. 34, T. 28 S., R. 15 E.

Drillia temblorensis, new species

Plate 7, figures 5a and 5b.

Shell small, fusiform, with seven or eight whorls; spire high with an acute apex; whorls angulated a little in front of the middle, flat above, convex below, sculptured with ten or eleven fine spiral cords which are crossed by numerous lines of growth; six spiral cords above the angle and four below, two of the latter slightly more prominent than those intervening; suture distinct, channeled; body-whorl with twenty-four spiral cords, those near the shoulder most prominent; aperture elliptical, with a simple outer lip; canal moderately short; columella smooth and twisted.

Dimensions:—Altitude of the type specimen, 13.5 mm.; maximum diameter of the last whorl, 5.5 mm.

Type:—No. 221, and cotype No. 222, Cal. Acad. Sci., lower Miocene of Kern River, California, locality 64, in the bottom of a small canyon about 1¼ miles due north of Barker's ranch house.

Drillia temblorensis resembles *Drillia inermis* Hinds, in having almost no axial ribs, and in having an ornamentation consisting chiefly of revolving lines. It may be distinguished from the latter by its fine axial ornamentation, few spiral cords, less distinct suture, and less angulated whorls.

Drillia bulwaldana, new species

Plate 7, figures 3a, 3b, and 3c.

Shell small, slender, solid, with eight to ten whorls; spire high, with an acute apex; whorls angulated a little above the middle producing prominent shoulders, very concave above, convex below, each whorl crossed by thirteen strong, rounded axial ribs with slightly wider interspaces, and numerous fine spiral threads of unequal size, three or four on each whorl more prominent than those intervening; the latter very fine, and scarcely raised, making the surface appear to be spirally striate; suture distinct, wavy, bordered below by a sutural collar about one-half millimeter in width; body-whorl with ten or twelve major spiral threads, slightly concave on the posterior portion, strongly nodose on the shoulder; aperture oval; canal short; columella incrusted; posterior sinus deep and narrow, between the suture and the angle.

Dimensions:—Altitude of the type specimen, 21 mm.; diameter of the last whorl, 7 mm.

Type:—No. 223, and cotypes Nos. 224 and 225, Cal. Acad. Sci., lower Miocene of Kern River, California, locality 68.

Drillia buwaldana somewhat resembles *Drillia montereyensis* Stearns but is larger, with less conspicuous sutural collar, more distinct whorls, longer canal, and few and more prominent axial ribs.

Named in honor of Mr. J. P. Buwalda.

Drillia antiselli, new species

Plate 7, figures 2a and 2b.

Shell small, solid, rather broadly fusiform; spire high with an acute apex; whorls six or seven, angulated a little in front of the middle, concave above, convex below, marked with four spiral lines, one on the angle and three below; suture distinct; body-whorl with ten or eleven spiral lines in front of the shoulder; aperture elliptical, with simple outer lip; canal short and broad, slightly recurved; columella incrusted, smooth, with anterior sulcus.

Dimensions:—Altitude of the type specimen, 17.5 mm.; diameter of the last whorl, 7.5 mm.; length of the aperture, including the canal, 9 mm.

Type:—No. 226, and cotype No. 227, Cal. Acad. Sci., lower Miocene of Kern River, California, locality 65, on the west bank of a small canyon, 1¼ miles northeast of Barker's ranch house.

Named in honor of Dr. Thomas Antisell.

Drillia ocoyana, new species

Plate 7, figures 1a and 1b.

Shell small, elongate, solid, with seven or eight whorls; spire elevated; whorls slightly convex or nearly flat, sculptured with numerous spiral grooves eight on the whorls of the spire and about twenty-five on the body-whorl; the interspaces between the spiral grooves on the body-whorl slightly raised and often divided by a small intercalary groove; numerous faint axial lines are visible on the upper whorls of some specimens; suture strongly appressed; body-whorl sharply rounded on the anterior margin, and angulated near the posterior margin on some specimens, concave above, broadly convex below; aperture elliptical, oblique, with an arcuate outer lip and a shallow posterior sinus; canal very short; columella concave, incrusted, with an umbilical chink.

Dimensions:—Altitude of the type specimen, 22 mm., with the first few whorls broken; diameter of the last whorl, 10 mm.; length of the aperture, including the canal, 10 mm.

Type:—No. 228, and cotype No. 229, Cal. Acad. Sci., lower Miocene of Kern River, California, locality 64, in the bottom of a small canyon about 1¼ miles due north of Barker's ranch house.

Drillia columbiana, new species

Plate 7, figures 4a and 4b.

Shell fusiform, small, with six or seven whorls; spire high, with an acute apex; whorls angulated a little below the middle, concave above with very fine spiral striations, flat below with two or three spiral threads, crossed by axial lines of growth; suture distinct, channeled; body-whorl convex in front of the shoulder, sculptured with nine or ten spiral threads having slightly wider interspaces which occasionally contain very fine intercalary lines; the spiral threads replaced by seven or eight striations on the anterior portion of the body-whorl; aperture ovate, with simple outer lip; canal short; columella twisted; posterior sinus broad and moderately deep.

Dimensions:—Altitude of the type, with defective apex, 9 mm.; diameter of the last whorl, 4.5 mm.

Type:—No. 231, and cotype No. 232, Cal. Acad. Sci., Oligocene(?) (or Miocene?) of northwestern Oregon.

Genus MANGILIA Risso

Mangilia kernensis, new species

Plate 7, figures 6a and 6b.

Shell slender and small, fusiform, with seven or eight whorls, spire high with an acute apex; whorls angulated a little above the middle, concave above, convex below, sculptured with twelve to fourteen axial ribs and about ten spiral threads, five of moderate size below the angle and four or five very fine spiral lines above the angle; axial ribs most prominent below the angle and rising to small nodes on the shoulder; interspaces equal in width to the ribs and frequently carrying intercalary lines; suture distinct, appressed; body-whorl ornamented with ten to twelve spiral threads between which are secondary spiral lines; aperture elliptical, with a simple outer lip; columella

slightly incrusted, straight; canal short, posterior sinus deep and narrow, near the suture.

Dimensions:—Altitude of the type, 6 mm.; diameter of the last whorl, 2 mm.

Type:—No. 233, and cotype No. 234, Cal. Acad. Sci., lower Miocene of Kern River, California, locality 65, on the west bank of a small canyon 1¼ miles northeast of Barker's ranch house.

Mangilia howei, new species

Plate 7, figure 7.

Shell small, fusiform, with five whorls; spire elevated; whorls slightly convex, crossed by seven strongly raised vertical ribs with wider interspaces; spiral sculpture consisting of fine threads which are most prominent on the anterior portion of the last whorl; aperture elliptical, with an arcuate outer lip; columella incrusted, canal short and wide.

Dimensions:—Altitude of the type specimen, 6 mm.; maximum diameter, 2.5 mm.

Type:—No. 234, Cal. Acad. Sci., lower Miocene of Kern River, California, locality 68, on the north bank of Kern River about ¾ mile west of the power plant and about 3 miles east of the Rio Bravo ranch house.

Genus BULLA Klein

Bulla cantuaënsis, new species

Plate 5, figures 3a and 3b.

Shell one inch or more in length, broadly elliptical, smooth or showing only regular lines of growth; aperture extending the full length of the shell, ovate in front, narrowed behind; outer lip longer than the body-whorl; umbilicus deep and narrow at the posterior end, closed or hidden anteriorly.

Dimensions:—Altitude of the type specimen, 24 mm.; diameter, 15 mm.

Occurrence:—Shells of this species are abundant in the Temblor beds just north of Cantua Creek and in beds of doubtful age west of Coalinga.

December 30, 1914.

Type:—No. 235, and cotype No. 236, Cal. Acad. Sci., from the Temblor beds one mile north of Cantua Creek, western Fresno County, California, where it is associated with *Turritella ocoyana* Conrad, *Chione temblorensis* Anderson, *Astrodapsis merriami* Anderson, and many other Temblor species.

EXPLANATION OF PLATE 1

All figures natural size

Fig. 1a. Chione panzana, new species. Type. Lower Miocene of San Luis Obispo Co., California.

Fig. 1b. Chione panzana, new species. Same locality as fig. 1a., showing the hinge plate.

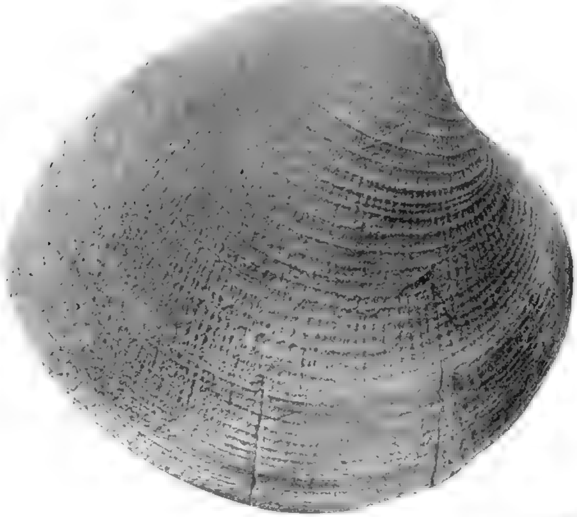
Fig. 2a. Chione (Lirophora) latilaminosa, new species. Type. Exterior of left valve. Lower Miocene of Kern River, California.

Fig. 2b. The same. Dorsal view.

Fig. 2c. The same. View of hinge plate of left valve.

Fig. 3a. Cardium weaveri, new species. Oligocene(?) (or Miocene) of northwestern Oregon.

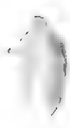
Fig. 3b. The same. Type. Same locality as fig. 3a.



1a

2a

2c



2b

3a

1b

3b

EXPLANATION OF PLATE 2

All figures natural size

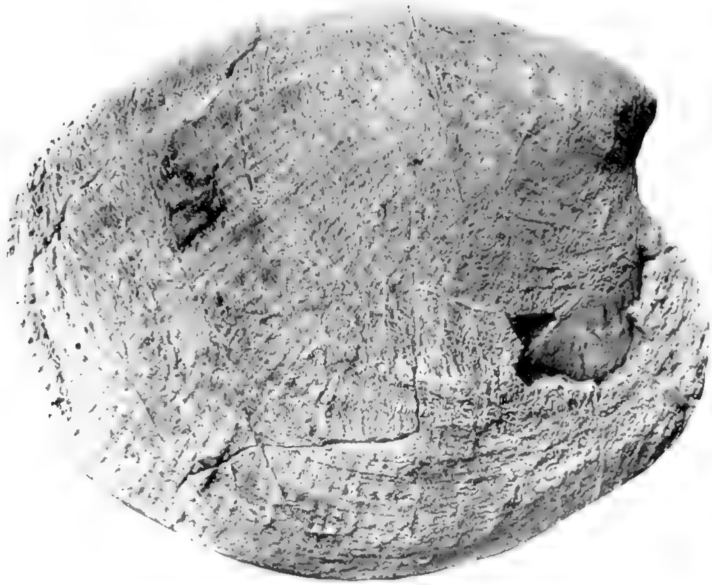
Fig. 1. Chione margaritana, new species. Type. Exterior of right valve. Santa Margarita Formation of the Coalinga region, California.

Fig. 2. Astrodapsis peltoides, new species. Type. Santa Margarita Formation of the Coalinga region, California.

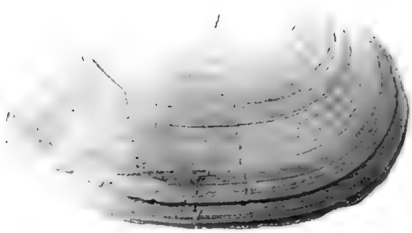
Fig. 3a. Tellina nevadensis, new species. Type. Exterior of right valve. Lower Miocene of Kern River, California.

Fig. 3b. The same. Exterior of left valve. Lower Miocene of San Luis Obispo County, California.

Fig. 3c. The same. Interior of the left valve. Same locality as fig. 3a.

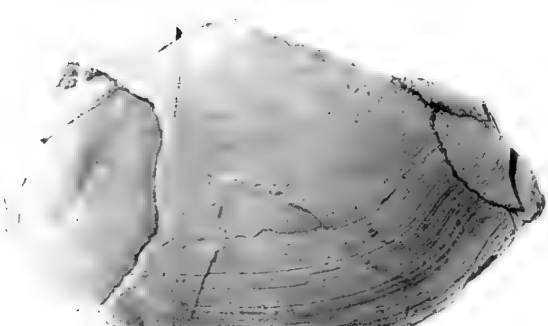


1

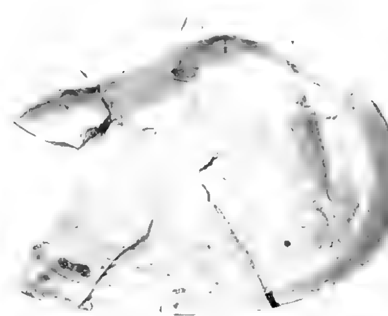


3a

2



3b



3c

EXPLANATION OF PLATE 3

Fig. 1a. Diplodonta buwaldana, new species. Natural size. Right valve. Lower Miocene of Kern River, California.

Fig. 1b. The same. Type. Natural size. Left valve. Same locality as fig. 1a.

Fig. 2. Yoldia newcombi, new species. Type. Natural size. Lower Miocene of Clallam County, California.

Fig. 3. Yoldia temblorensis, new species. Type. Natural size. Lower Miocene of Kern River, California.

Fig. 4. Semele morani, new species. Type. Natural size. Lower Miocene of San Luis Obispo County, California.

Fig. 5a. Mactra sectoris, new species. Type. Natural size. Lower Miocene of Kern River, California.

Figs. 5b, 5c, 5d, and 5e. The same. Natural size. Same locality as fig. 5a.

Fig. 6a. Transennella joaquinensis, new species. Type. $\times 2$. Lower Miocene of Kern River, California.

Figs. 6b and 6c. The same. $\times 2$. Same locality as fig. 6a.

Fig. 7a. Poromya gabbiana, new species. Type. Natural size. Exterior of right valve. Lower Miocene of eastern San Luis Obispo County, California.

Fig. 7b. The same. Natural size. Same locality as fig. 7a.

Fig. 8a. Leda ochsneri, new species. Type. Natural size. Lower Miocene of Kern River, California.

Figs. 8b and 8c. The same. Natural size. Same locality as fig. 8a.

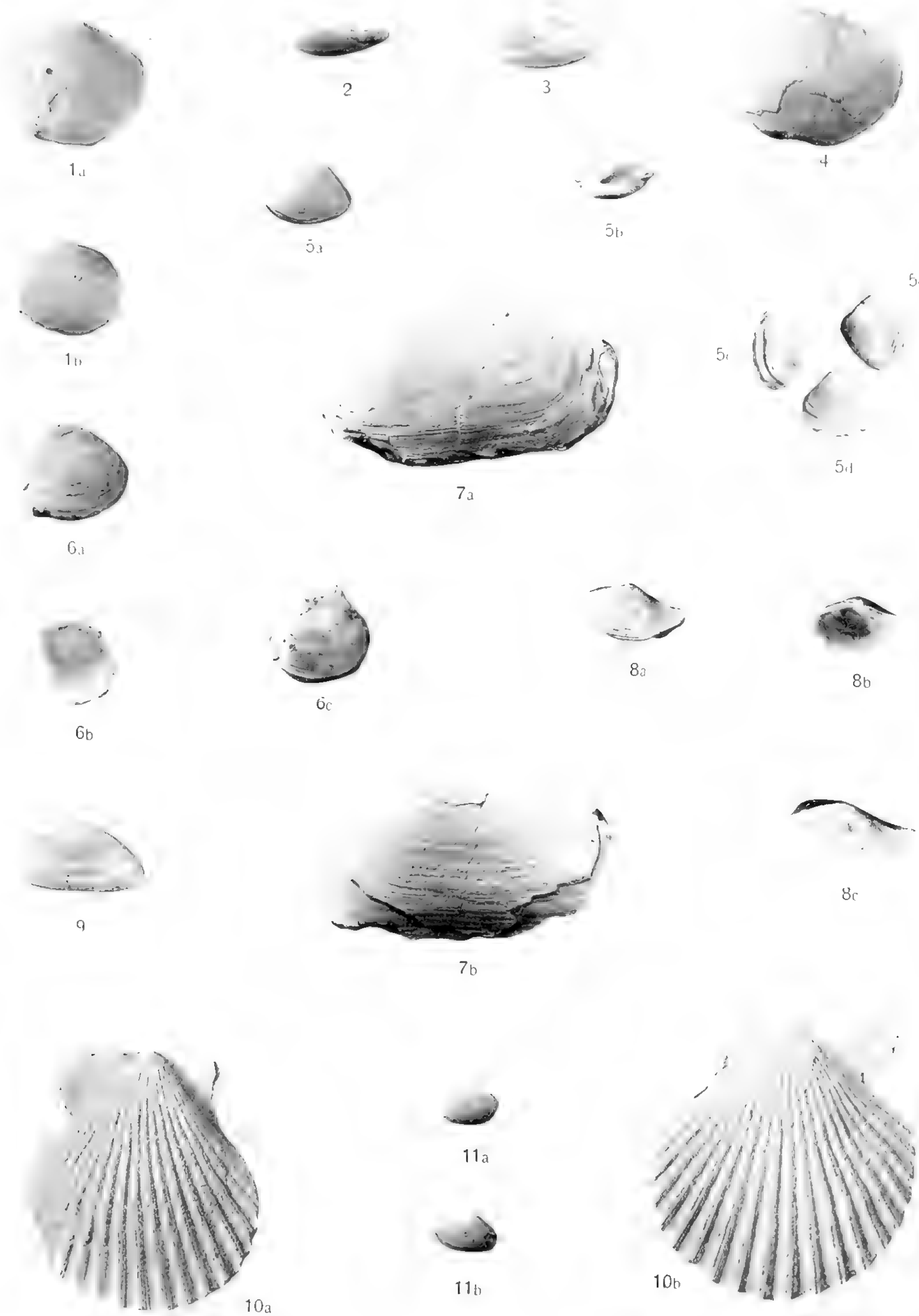
Fig. 9. Donax triangulata, new species. Type. $\times 2$. Lower Miocene of Kern River, California.

Fig. 10a. Pecten sancti-ludovici, new species. Type. Natural size. Right valve. Middle Miocene of eastern San Luis Obispo County, California.

Fig. 10b. The same. Natural size. Showing the left valve. Same locality as fig. 10a.

Fig. 11a. Tellina wilsoni, new species. Type. Natural size. Lower Miocene of eastern San Luis Obispo County, California.

Fig. 11b. The same. Natural size. The same locality as fig. 11a.


1a
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5b
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5c
5c
5d
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6a
6b
6c
8a
8b
9
7b
8c
10a
11a
11b
10b

EXPLANATION OF PLATE 4

All figures natural size

Fig. 1. Melongena californica, new species. Type. Lower Miocene of eastern San Luis Obispo County, California.

Fig. 2. Siphonalia posoensis, new species. Type. Same locality as fig. 1.

Fig. 3a. Agasoma oregonense, new species. Type. Oligocene(?) of northwestern Oregon.

Fig. 3b. Agasoma oregonense, new species. Same locality as fig. 3a.

Fig. 4. Turritella carrisaensis, new species. Type. Middle Miocene of eastern San Luis Obispo County.

Fig. 5a. Agasoma yaquinanum, new species. Type. Miocene of the Oregon coast, four miles north of Yaquina Bay.

Fig. 5b. The same. Same locality as fig. 5a.

Fig. 6a. Chrysodomus kernensis, new species. Type. Lower Miocene of Kern River, California.

Fig. 6b. The same. Same locality as fig. 6a.

Fig. 7. Argobuccinum dilleri, new species. Type. Miocene of the Oregon coast, six miles north of Yaquina Bay.


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3a
4
3b
5a
5b
6a
7
6b

EXPLANATION OF PLATE 5

All figures natural size

Fig. 1. Trophon gabbianus Anderson. Type locality, North of Coalinga, California.

Fig. 2a. Turris carlsoni, new species. Type. Miocene of the Oregon coast, six miles north of Yaquina Bay.

Fig. 2b. Turris carlsoni, new species. Same locality as fig. 2a.

Fig. 3a. Bulla cantuaënsis, new species. Type. Lower Miocene north of Coalinga, California.

Fig. 3b. Bulla cantuaënsis, new species. Same locality as fig. 3a.

Fig. 4a. Agasoma acuminatum, new species. Type. Oligocene(?) of northwestern Oregon.

Fig. 4b. The same. Same locality as fig. 4a.

Fig. 5. Trophon oregonensis, new species. Type. Miocene of the Oregon coast, four miles north of Yaquina Bay.

Fig. 6a. Agasoma columbianum, new species. Type. Oligocene(?) of Pittsburg Bluff, Columbia County, Oregon.

Fig. 6b. The same. Same locality as fig. 6a.

Fig. 7. Fusinus empireënsis, new species. Type. Empire Formation of Coos Bay, Oregon.


1
2b
2a
3b
4a
5
4b
3a
6a
7
6b

EXPLANATION OF PLATE 6

All figures natural size

Fig. 1a. Thais trophonoides, new species. Type. Lower Miocene of Kern River, California.

Fig. 1b. The same. Same locality as fig. 1a.

Fig. 2a. Cancellaria sanjosei, new species. Type. Lower Miocene of eastern San Luis Obispo County, California.

Fig. 2b. The same. Same locality as fig. 2a.

Fig. 3. Thais nehalemensis, new species. Type. Oligocene(?) of northwestern Oregon.

Fig. 4a. Thais blakei, new species. Type. Lower Miocene of Kern River, California.

Fig. 4b. The same. Same locality as fig. 4a.

Fig. 5a. Molopophorus gabbi Dall. Oligocene(?) of Pittsburg Bluff, Columbia County, Oregon.

Fig. 5b. The same.

Fig. 6. Thais panzana, new species. Type. Lower Miocene of eastern San Luis Obispo County, California.

Fig. 7a. Molopophorus dalli, new species. Type. Oligocene(?) of Pittsburg Bluff, Columbia County, Oregon.

Fig. 7b. The same. Same locality as fig. 7a.

Fig. 8. Turris lincolnensis, new species. Type. Miocene of the Oregon coast, six miles north of Yaquina Bay.

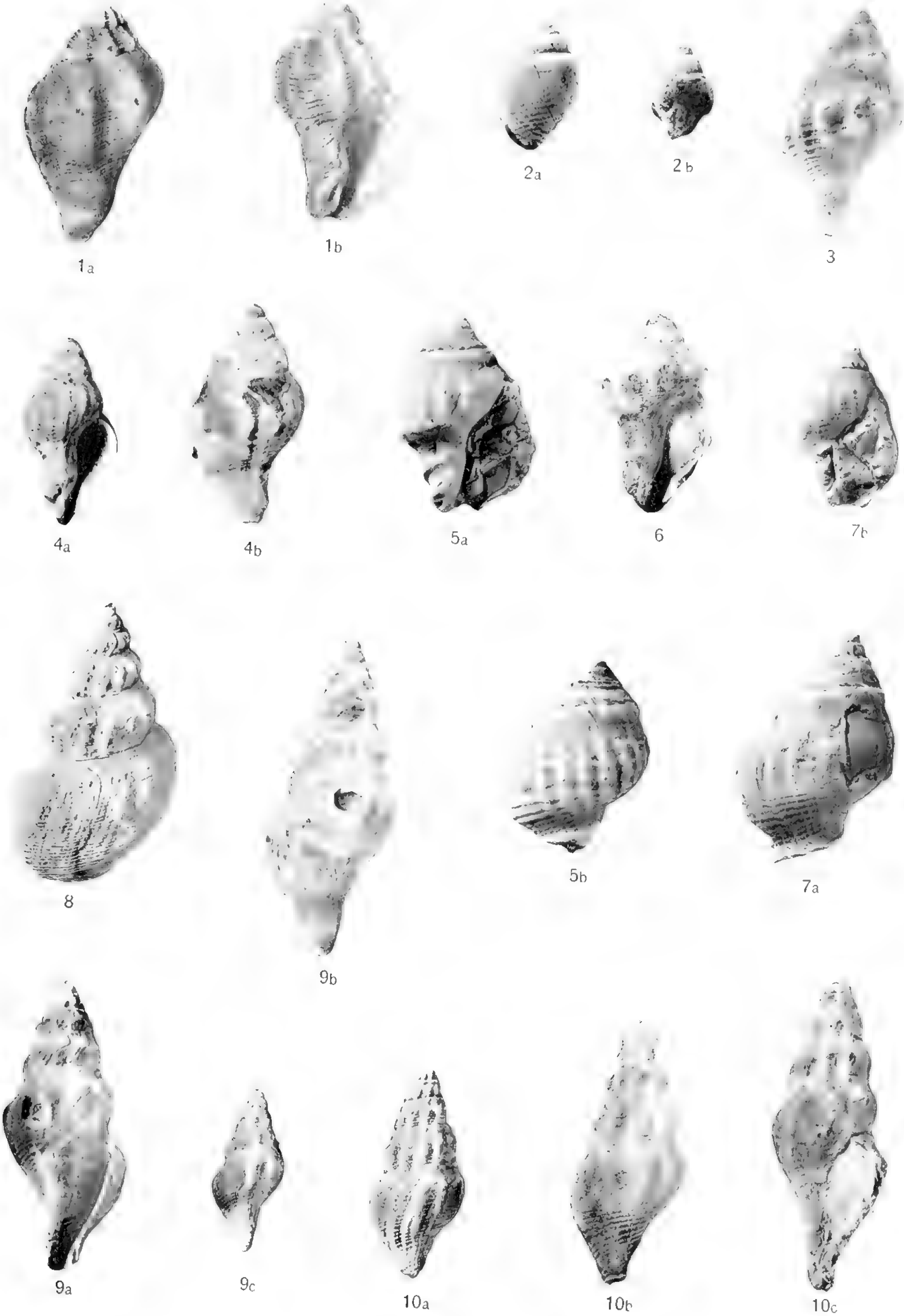
Fig. 9a. Drillia ochsneri, new species. Type. Lower Miocene of Kern River, California.

Fig. 9b. The same. Same locality as fig. 9a.

Fig. 9c. The same. Same locality as fig. 9a.

Fig. 10a. Drillia wilsoni, new species. Type. Lower Miocene of eastern San Luis Obispo County, California.

Figs. 10b and 10c. The same. The same locality as fig. 10a.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2b
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5a
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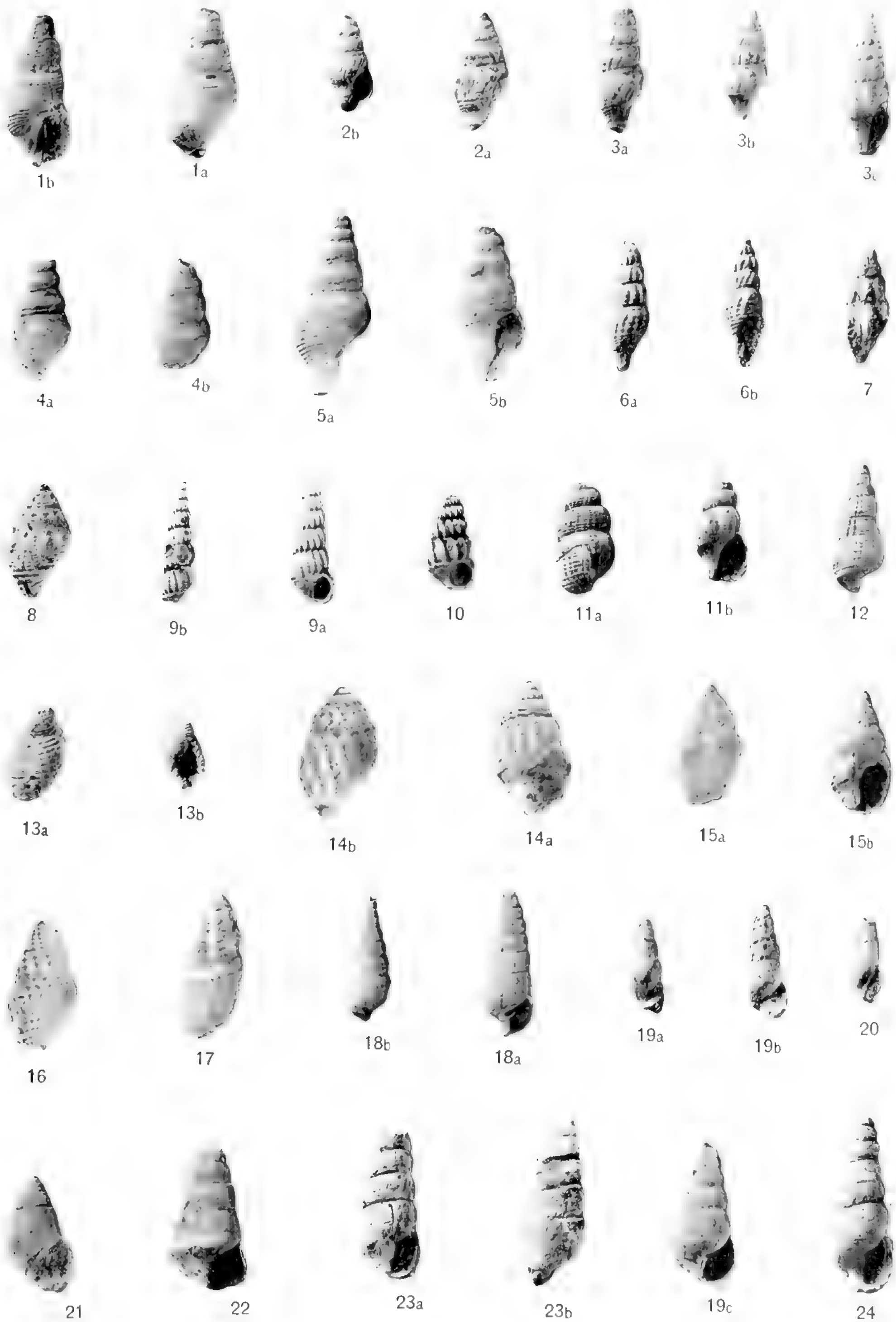
7b
8
9b
5b
7a
9a
9c
10a
10b
10c

EXPLANATION OF PLATE 7

Fig. 1a. Drillia ocoyana, new species. Type. Natural size. Lower Miocene of Kern River, California.
Fig. 1b. The same. The same locality as fig. 1a.
Fig. 2a. Drillia antiselli, new species. Type. Natural size. Lower Miocene of Kern River, California.
Fig. 2b. The same. Same locality as fig. 2a.
Fig. 3a. Drillia buwaldana, new species. Type. Natural size. Lower Miocene of Kern River, California.
Figs. 3b and 3c. The same. Same locality as fig. 3a.
Fig. 4a. Drillia columbiana, new species. Type. ×2. Oligocene(?) of northwestern Oregon.
Fig. 4b. The same. Same locality as fig. 4a.
Fig. 5a. Drillia temblorensis, new species. Type. ×2.
Fig. 5b. The same. Same locality as fig. 5a.
Fig. 6a. Mangilia kernensis, new species. Type. ×3. Same locality as fig. 1a.
Fig. 6b. The same. ×3. Same locality as fig. 1a.
Fig. 7. Mangilia howei, new species. Type. ×3. Lower Miocene of Kern River, California.
Fig. 8. Bathytoma condoniana, new species. Type. Natural size. Miocene of the Oregon coast, four miles north of Yaquina Bay.
Fig. 9a. Epitonium williamsoni, new species. Type. Natural size.
Fig. 9b. The same. Natural size. Same locality as fig. 9a.
Fig. 10. Epitonium posoënsis, new species. Type. Natural size. Lower Miocene of Kern River.
Fig. 11a. Amphissa posunculensis, new species. Type. Natural size.
Fig. 11b. The same. Natural size. Same locality as fig. 11a.
Fig. 12. Cerithium arnoldi, new species. Type. Natural size. Lower Miocene of Kern River, California.
Fig. 13a. Fossarus dalli, new species. Type. ×3. Lower Miocene of Kern River, California.
Fig. 13b. The same. ×3. The same locality as fig. 13a.
Fig. 14a. Nassa lincolnensis, new species. ×2. Type Oligocene(?) of northwestern Oregon.
Fig. 14b. Nassa lincolnensis, new species. ×2. Same locality as fig. 14a.
Fig. 15a. Nassa blakei, new species. Type. ×2. Lower Miocene of Kern River, California.
Fig. 15b. The same. ×2. Same locality as fig. 15a.
Fig. 16. Nassa antiselli, new species. Type. ×2. Eastern San Luis Obispo County, California.
Fig. 17. Nassa ocoyana, new species. Type. ×2. Lower Miocene of Kern River, California.
Fig. 18a. Pyramidella cooperi, new species. ×2. Type. Lower Miocene of Kern River, California.
Fig. 18b. The same. ×2. The same locality as fig. 18a.
Fig. 19a. Eulimella californica, new species. Type. ×3. Lower Miocene of Kern River, California.
Figs. 19b and 19c. The same. ×3.
Fig. 20. Eulimella gabbiana, new species. Type. ×3. Lower Miocene of Kern River, California.
Fig. 21. Lacuna carpenteri, new species. Type. ×2. Lower Miocene of Kern River, California.
Fig. 22. Niso antiselli, new species. Type. ×3. Lower Miocene of Kern River, California.
Fig. 23a. Eulimella ochsneri, new species. Type. ×3. Lower Miocene of Kern River, California.
Fig. 23b. The same. ×3. The same locality as fig. 23a.
Fig. 24. Eulimella dilleri, new species. Type. ×3. Oligocene(?) of northwestern Oregon.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11a
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14b
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15b
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18b
18a
19a
19b
20
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22
23a
23b
19c
24

EXPLANATION OF PLATE 8

All figures natural size except figs. 3a and 3b.

Figs. 1a, 1b, 1c, and 1d. Cancellaria dalliana Anderson. Lower Miocene of Kern River, California.

Fig. 2a. Calliostoma pacificum, new species. Type. Oligocene(?) of northwestern Oregon.

Fig. 2b. The same. Same locality as fig. 2a.

Fig. 3a. Admete clatskaniënsis, new species. Type. ×2. Oligocene(?) of northwestern Oregon.

Fig. 3b. The same. ×2. Same locality as fig. 3b.

Fig. 4a. Cancellaria rotunda, new species. Type. Oligocene(?) of northwestern Oregon.

Fig. 4b. The same. Same locality as fig. 4a.

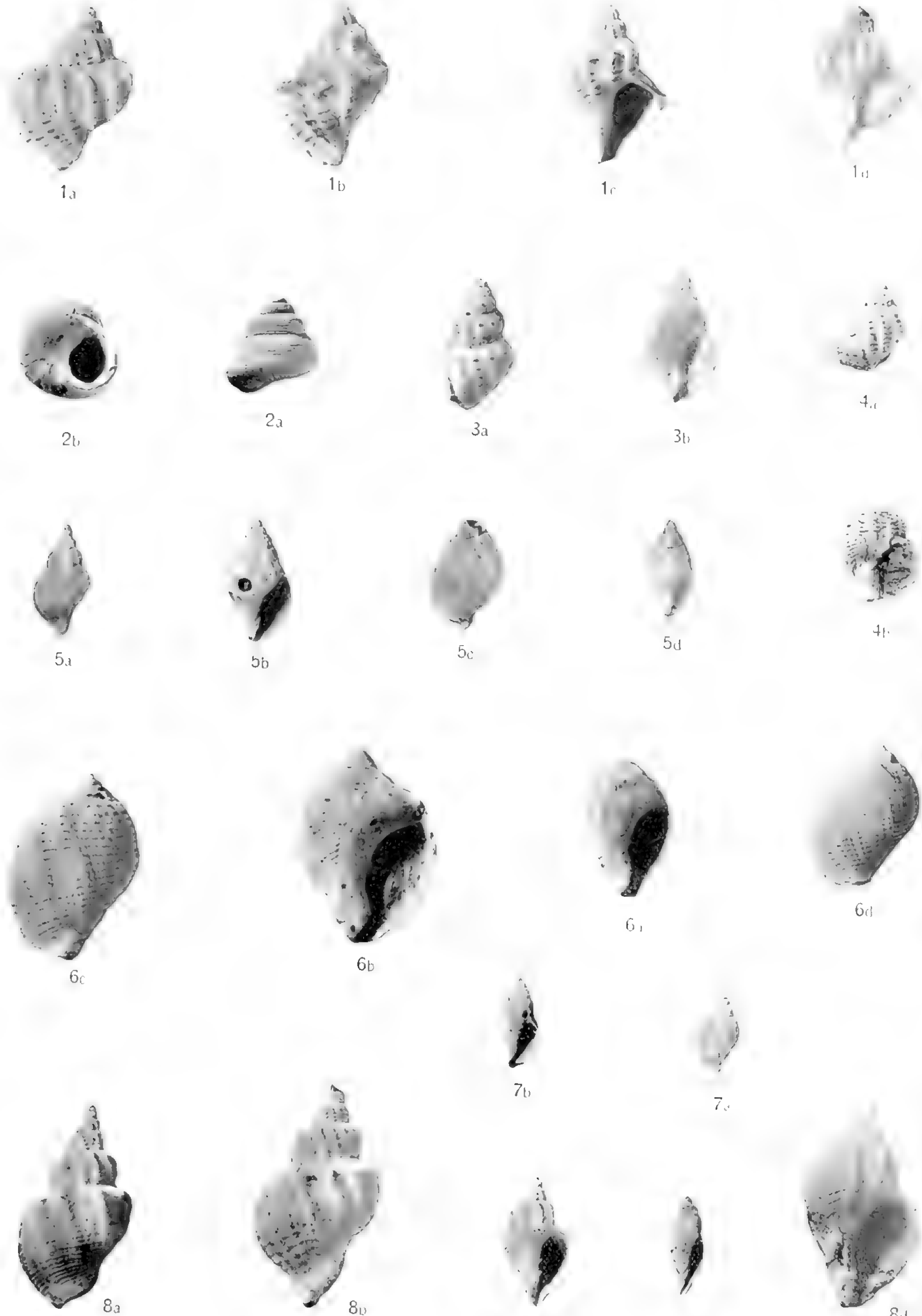
Fig. 5a. Cancellaria nevadensis, new species. Type. Lower Miocene of Kern River, California.

Figs. 5b, 5c, and 5d. The same. Kern River.

Figs. 6a, 6b, 6c, and 6d. Cancellaria lickana, new species. Fig. 6a, type. Lower Miocene of Kern River, California.

Figs. 7a, 7b, and 7c. Cancellaria posunculensis, new species. Fig. 7a Type. Lower Miocene of Kern River, California.

Figs. 8a, 8b, 8c, and 8d. Cancellaria condoni Anderson. Lower Miocene of Kern River, California.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8d

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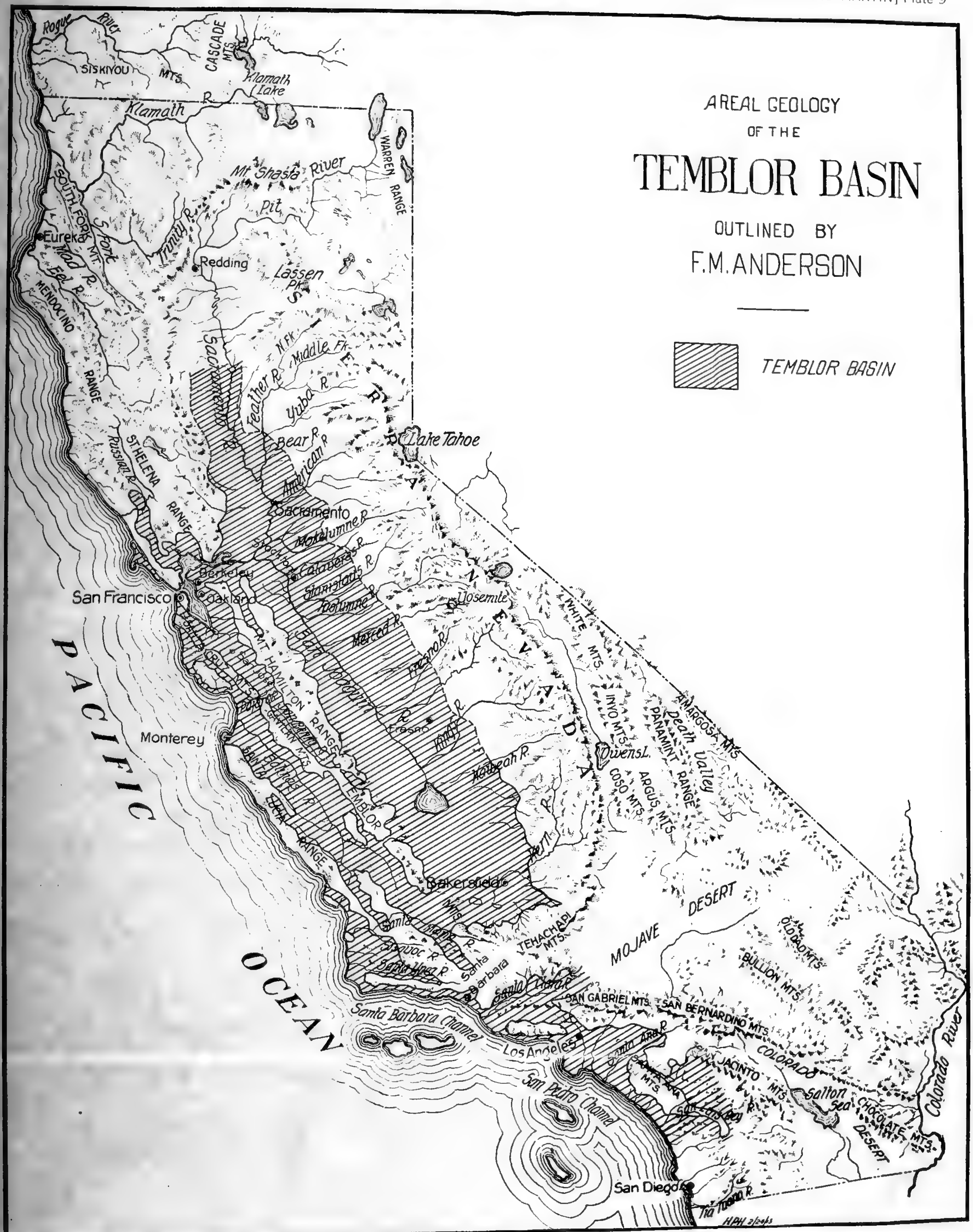
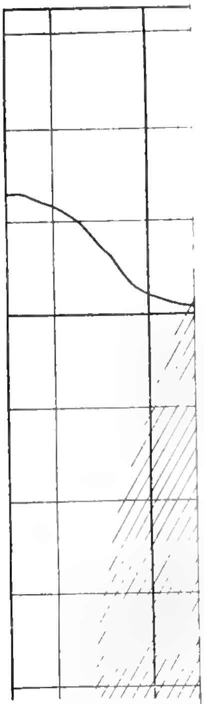
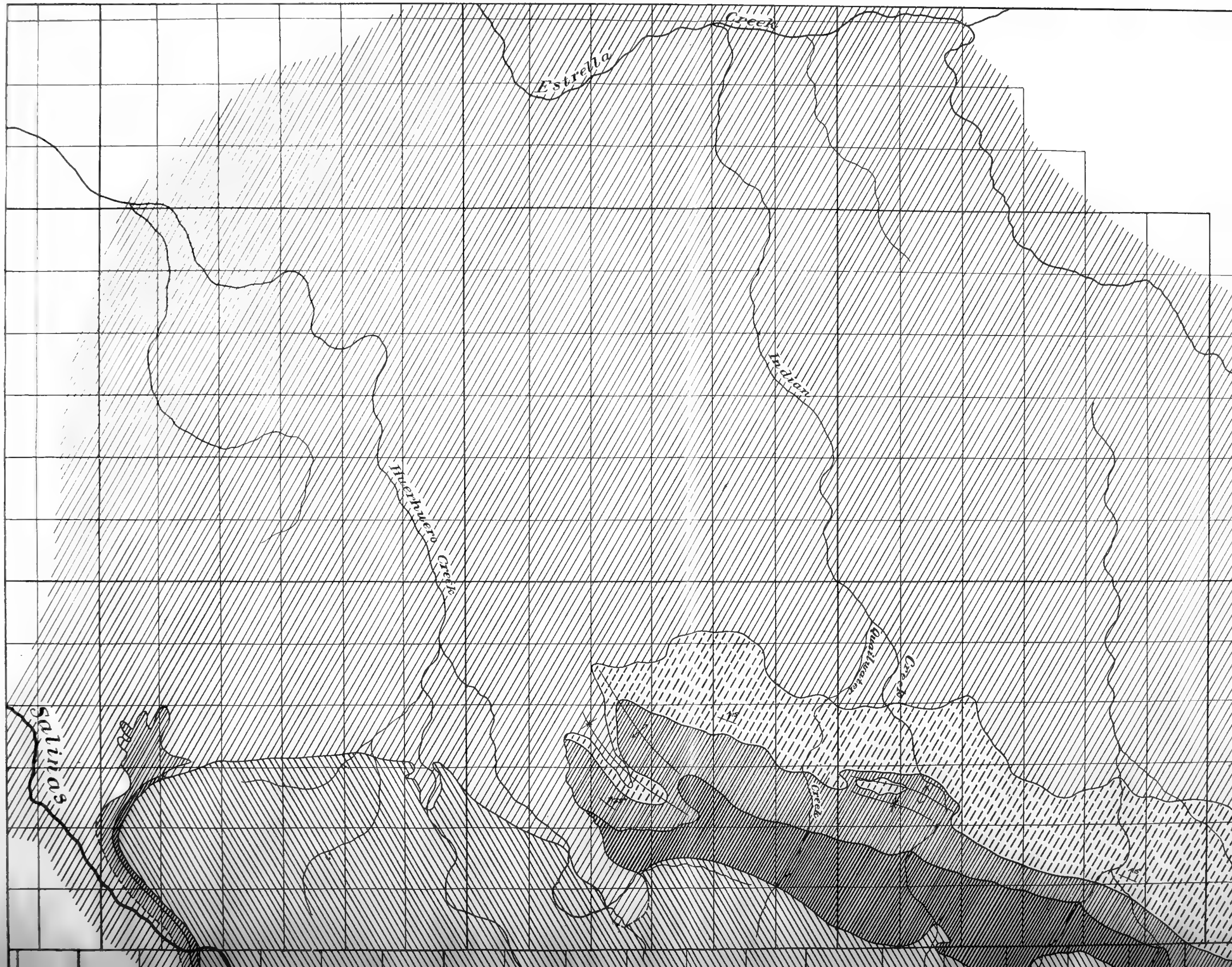
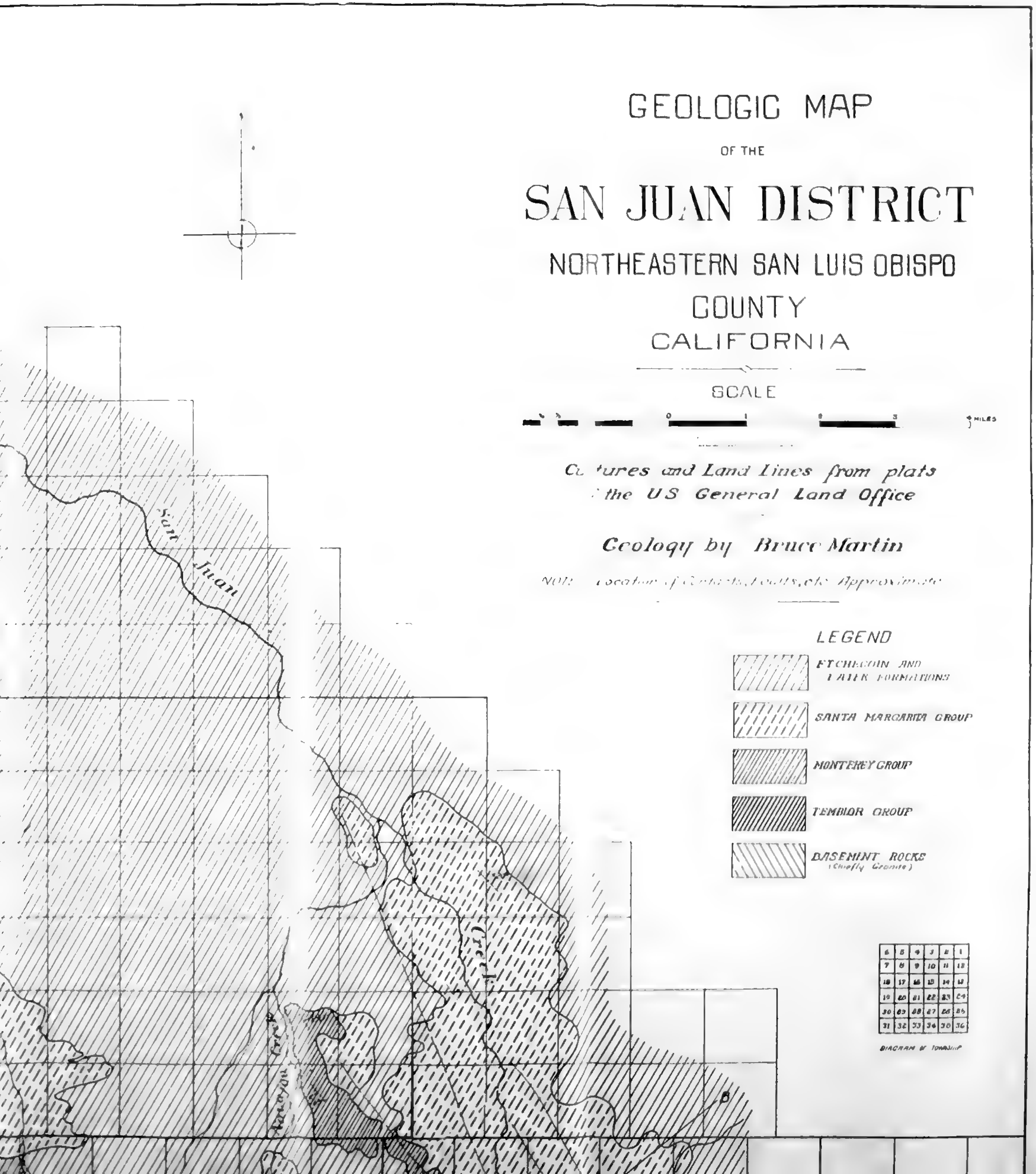
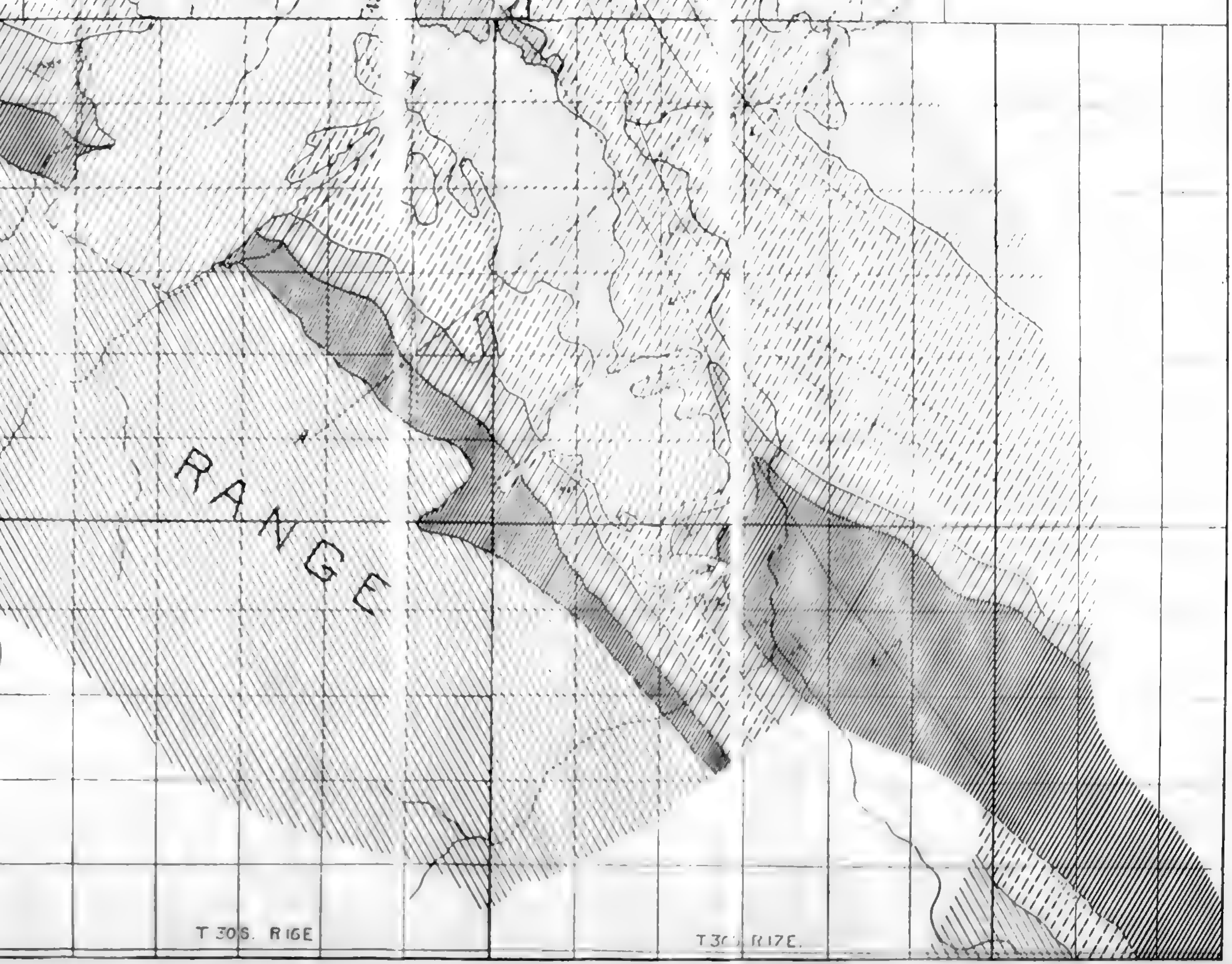

AREAL GEOLOGY
OF THE
TEMBLOR BASIN
OUTLINED BY
F.M. ANDERSON
TEMBLOR BASIN
PACIFIC
OCEAN
San Francisco
Berkeley
Oakland
Monterey
Sacramento
Redding
Eureka
Fresno
Bakersfield
Los Angeles
San Diego
Lake Tahoe
Yosemite
Owens L.
Salton Sea
SIERRA NEVADA
SISKIYOU MTS.
CASCADE MTS.
WARREN RANGE
MENDOCINO RANGE
ST. HELENA RANGE
MT. HAMILTON RANGE
TEMBLOR
TEHACHAPI MTS.
SAN GABRIEL MTS.
SAN BERNARDINO MTS.
WHITE MTS.
INYO MTS.
COSO MTS.
ARGUS MTS.
PANAMINT RANGE
AMARGOSA MTS.
Death Valley
MOJAVE DESERT
BULLION MTS.
OLD DAD MTS.
COLORADO DESERT
CHOCOLATE MTS.
Santa Barbara Channel
San Pedro Channel
Colorado River
Klamath Lake
Klamath R.
Mt. Shasta
Lassen Pk.
Kaweah R.
Merced R.
Mokelumne R.
Calaveras R.
Stanislaus R.
Tuolumne R.
Bear R.
American R.
Yuba R.
Feather R.
Russian R.
Eel R.
Mad R.
Trinity R.
Santa Ana R.
Tia Juana R.
HPH




Estrella
Creek
Indian
Huerhuero
Creek
Salinas
Creek
Creek
Creek
Creek


GEOLOGIC MAP
OF THE
SAN JUAN DISTRICT
NORTHEASTERN SAN LUIS OBISPO
COUNTY
CALIFORNIA
SCALE
MILES
the US General Land Office
Geology by Bruce Martin
LEGEND
SANTA MARGARITA GROUP
MONTEREY GROUP
TEMBLOR GROUP
BASEMENT ROCKS
San
Juan
Creek
DIAGRAM OF TOWNSHIP


SAN
JOSE
River
A
B
Section along Line AB
LEGEND
ETCHEGOIN AND LATER FORMATIONS
SANTA MARGARITA
MONTEREY
TEMBLOR
GRANITE



RANGE
T 30 S. R 16 E
T 30 ... R 17 E.

PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

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The Fauna of the Siphonalia sutterensis Zone in the Roseburg Quadrangle, Oregon

BY

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Introduction.

A definite connecting link between the Tejon group of Oregon and that of California appears to be present in the uppermost portion of the Umpqua formation on the Umpqua River near the mouth of Little River. The fauna upon which this correlation is based was obtained by Mr. Bruce Martin, until recently Assistant Curator of Paleontology of the California Academy of Sciences.

The Siphonalia sutterensis Zone of California is found typically at the Marysville Buttes.[1] Other localities where it has been recognized also are at Oroville[2] beneath the Older Basalt of Oroville, South Table Mountain, and near Ione[3], Amador County, California, and near Merced Falls, Merced County, California.

In all of these localities this zone of the Tejon group is the only one present, the lower portion of the Tejon being absent. The beds at the Marysville Buttes containing the Siphonalia sutterensis fauna rest directly upon rocks of Chico-Cretaceous

1 Dickerson, R. E., Fauna of the Eocene at Marysville Buttes, California, Univ. Calif. Publ., Bull. Dept. Geol., vol. 7, pp. 257-298, 1913.

2 Dickerson, R. E., Note on the Faunal Zones of the Tejon group, Univ. Calif. Publ., Bull. Dept. Geol., vol. 8, pp. 17-25, 1914.

3 Dickerson, R. E., The Ione Formation of the Sierra Nevada Foothills, A Local Facies of the Upper Tejon-Eocene, Science, New Series, vol. 40, pp. 67-70, 1914.

age. The beds at Oroville were laid down upon the Basement Complex of the Sierra Nevada and the Chico. The so-called Ione formation, a local facies of the Tejon group which occurs typically at Ione and at Merced Falls, rests unconformably upon the Mariposa slates and other members of the Basement Complex.

At the Oregon locality, however, a great thickness of ten thousand feet of Tejon strata lies below the beds which yielded the fauna described in this paper. The writer's previous conclusions from a study of the Siphonalia sutterensis fauna were based upon stage of evolution, identity of a few species whose ranges were limited to the uppermost beds in the Tejon in the San Francisco Bay region, and the absence of many species which were characteristic of the lower zones of the Tejon. The recognition of the Siphonalia sutterensis fauna in Oregon gives stratigraphic confirmation concerning the position of this fauna in the Eocene time scale of the Pacific Coast; i. e., the Siphonalia sutterensis Zone is the youngest Eocene thus far recognized on the Pacific Coast.

STRATIGRAPHY.

The stratigraphic relations at the two collection points are described by Martin as follows: "The beds at locality 24 dip east at a low angle. The strike is nearly north and south. The rock at this locality is a massive, blue-gray sandstone overlaid by shale." At locality 25, Martin observed a dip of 20° East and a strike of North 10° East.

Mr. Diller, in the Roseburg Folio, describes this section as follows: "The Umpqua is by far the thickest formation in the Roseburg Quadrangle, but, on account of the lack of good exposures of certain members of the series, the whole could not be accurately measured. The best outcrops are along the Little River, where a continuous section of a portion of the series is well exposed. This portion has a thickness of about 7500 feet. It is interrupted on the northwest by the large mass of diabase, beyond which, as shown in Section B, about 4500 feet of still lower beds are seen, making a total thickness of approximately 12,000 feet for the entire exposed formation. It increases in thickness to the northwest and has wide distribution throughout the Coast Range." Diller's Section B places the localities described above about 2000 feet below the top of the Tejon.

FAUNAL RELATIONS.

The fauna obtained at these two localities is as follows:

LIST OF FOSSILS FROM THE UMPQUA FORMATION.

	25	24
Barbatia morsei Gabb		×
Cardium marysvillensis Dickerson	×	
Cardium breweri Gabb	×	×
Crassatellites semidentata Cooper	×	×
Crassatellites washingtoniana Weaver	×	×
Corbula parilis Gabb	×	
Corbula hornii Gabb		×
Dosinia, species		×
Glycimeris sagitata Gabb	×	
Glycimeris cocenica Weaver	×	
Lucina(?) *cretacea* Gabb		×
Modiolus ornatus (Gabb)	×	
Meretrix hornii Gabb	×	×
Meretrix ovalis Gabb	×	
Macrocallista conradiana (Gabb)	×	
Psammobia æqualis (Gabb)	×	
Pitaria martini, new species	×	×
Ostrea idriaensis Gabb	×	×
Tivela weaveri, new species	×	×
Venericardia planicosta merriami, new subspecies	×	×
Venus aequilateralis Gabb	×	
Amauropsis andersoni, new species	×	×
Amauropsis alveata Gabb	×	×
Amauropsis umpquaënsis, new species	×	×
Ancilla (*Oliverato*) *californica* Cooper	×	
Caricella stormsiana Dickerson	×	
Cerithiopsis alternata Gabb	×	
Cassidaria tuberculata (Gabb)	×	
Clavella, species	×	
Calyptræa excentrica (Gabb)	×	×
Cylichna costata Gabb	×	×
Chrysodomus martini Dickerson	×	
Dentalium, species	×	
Ficopsis remondii Gabb	×	
Ficopsis cooperi Gabb	×	
Loxotrema turrita Gabb	×	×
Natica hannibali, new species	×	
Neverita nuciformis Gabb	×	
Neverita secta Gabb	×	×
Neverita globosa Gabb		×
Olivella mathewsonii Gabb	×	×
Potamides carbonicola Cooper	×	×
Pseudoliva dilleri, new species	×	×
Rimella canalifera Gabb	×	
Siphonalia sutterensis Dickerson	×	×
Surcula davisiana (Cooper)	×	
Tritonium hornii Gabb		×
Turritella uvasana Gabb	×	×
Turritella merriami Dickerson	×	
Turris suturalis (Cooper)	×	

Several forms in this fauna have not been previously reported from any other localities except those of the Marysville Buttes and Oroville South Table Mountain. These species are as follows: *Chrysodomus martini, Cardium marysvillensis, Siphonalia sutterensis, Caricella stormsiana, Surcula davisiana,* and *Venericardia planicosta merriami,* new subspecies. In addition to these species, *Ancilla (Oliverato) californica, Turris suturalis* and *Neverita globosa,* while not restricted to the Siphonalia sutterensis Zone of the Tejon group of California, are quite characteristic and abundant in this zone. The other species, except the new ones listed, have a great range in the Tejon of California and most of them are found throughout its entire thickness. *Amauropsis alveata, Rimella canalifera,* and *Turritella uvasana,* have not as yet been reported from the Siphonalia sutterensis Zone of the Marysville Buttes. These three species are very common forms in the portion of the Tejon below the Siphonalia sutterensis Zone. The occurrence of these forms along with the characteristic forms of the Siphonalia sutterensis Zone determines the position of the strata containing this fauna in reference to the faunal zones of the Tejon group of California. The fauna seems to present a stage of development between that of Zone 3 of the Diablo region and the fauna of the Siphonalia sutterensis Zone of the Marysville Buttes. The fauna obtained from the uppermost portion of the Umpqua formation appears to be more closely related to the Siphonalia sutterensis Zone than to the fauna of Zone 3, and on this account, it is tentatively placed as the lowermost portion of the Siphonalia sutterensis Zone.

Locality 24 is situated on the east bank of the north fork of the Umpqua. It is near the bend of the river, one-quarter of a mile north of Glide postoffice. It is in the southwest quarter of Sec. 18, T. 26 S., R. 3 W.

Locality 25 is on the east bank of the Little River, and underneath the bridge which crosses it at its mouth. It is near the center of Sec. 19, T. 26 S., R. 3 W.

PITARIA MARTINI, new species.

Plate 11, figures *2a, 2b, 2c.*

Shell of moderate size; elongate, with beaks slightly anterior of the center; anterior dorsal margin somewhat concave; the slightly convex posterior dorsal margin sloping less steeply than the anterior margin; anterior end sharply rounded; posterior end narrowly rounded; ventral margin convex, fluted; a marked umbonal ridge extending to a point on the ventral margin two-fifths of the distance from the posterior end; a shallow groove running posteriorly, and parallel to the umbonal ridge; lunule long, narrow; escutcheon indistinct.

Dimensions: Height, 32mm; length, 42mm.

Type:—No. 237, and cotype, No. 238, California Academy of Sciences. Locality 25, Roseburg Quadrangle, Oregon, near the center of Sec. 19, T. 26 S., R. 3 W., on the east bank of Little River at its confluence with the Umpqua, underneath the bridge at that point.

Named for Mr. Bruce Martin, sometime Assistant Curator of Paleontology, California Academy of Sciences.

TIVELA WEAVERI, new species.

Plate 11, figures *3a, 3b, 3c.*

Shell trigonal, with beak central, equivalve; the nearly straight anterior margin sloping steeply to a narrowly rounded anterior end; the slightly convex posterior margin sloping almost as steeply as the anterior; posterior end rounded broadly; base broadly rounded; hinge of right valve exhibiting three strong cardinals and a socket for a lateral in the anterior portion of hinge plate; pallial sinus appearing to be a small V-shaped one; lunule and escutcheon indistinct.

Dimensions: Height, 29mm; width, 31mm.

This species resembles *Crassatellites grandis* (Gabb) in general form. Its shell and hinge plate are not nearly so heavy as those of *C. grandis.* Common at localities 24 and 25.

Type:—No. 239, and cotype, No. 240, Cal. Acad. Sci. Locality 25, Roseburg Quadrangle, Oregon, near the center of Sec. 19, T. 26 S., R. 3 W., on the east bank of Little River at its confluence with the Umpqua, underneath the bridge at that point.

Named in honor of Professor Charles E. Weaver of the University of Washington.

VENERICARDIA PLANICOSTA MERRIAMI, new subspecies.

Plate 11, figures 1*a* and 1*b*.

This subspecies of *V. planicosta* is apparently the end member of an evolutionary series which begins with the typical *V. planicosta* in the Martinez, the Lower Eocene group of California. The middle member is *V. planicosta hornii* (Gabb) of the lower Tejon. This form in the adult stage lacks the marked radial ribbing of *V. planicosta hornii* (Gabb), and it is in general a higher form as well. The concentric ribbing of this form is much stronger than that of the lower Tejon subspecies. Young individuals, however, resemble the lower Tejon form so closely that one is not warranted in recognizing the subspecies upon the basis of the immature forms.

Dimensions: Height, 70mm; length, 70mm.

This subspecies resembles *V. potapacoensis* Clark & Martin, of the Maryland Eocene in that the radial ribbing in both forms is becoming obsolescent. They appear to differ in shape, however. The type, which is figured, is an extreme case of lack of radial ribbing. Other specimens associated with it at the same locality show fairly distinct ribbing in the neighborhood of the umbones. This species is one of the most characteristic forms of the Siphonalia sutterensis Zone. It occurs abundantly but poorly preserved at a University of California locality eight miles south of Ione, Amador County, California, at the O'Neill Sandstone Quarry, Sec. 27, T. 5 N., R. 10 E., Mt. Diablo B. L. and M., in strata which were previously recognized as Ione. It is associated at this place with *Meretrix hornii* Gabb, *Turritella merriami* Dickerson, and a few other species. This fauna proves the Ione to be only a facies of the Tejon Eocene.

Type:—No. 241, and cotype, No. 242, Cal. Acad. Sci. Locality 25, Roseburg Quadrangle, Oregon, near the center of Sec. 19, T. 26 S., R. 3 W., on the east bank of Little River, at its confluence with the Umpqua, underneath the bridge at that point.

Named in honor of Professor J. C. Merriam of the University of California.

NATICA HANNIBALI, new species.

Plate 12, figures 5*a* and 5*b*.

Shell large, with low, partially immersed spire and very large subquadrate body-whorl; whorls five or six in number, the penultimate whorl partially covered by body-whorl; upper portion of body-whorl and the penultimate whorl forming a somewhat flattened surface above which the small spire rises abruptly; sides of spire-whorls only slightly convex and sloping away from the immersed linear suture with a uniform angle; the portion of the body-whorl near the suture rising above the suture and forming a distinct ridge; the portion of the whorl a short distance below this ridge concave, making a groove similar to that of the genus *Gyrodes;* a marked swelling below this groove making a shoulder about a third of the whorl length below the suture; anterior two-thirds of body-whorl only slightly convex; peculiar incremental lines mark the body-whorl and further emphasize its peculiarities; these lines bowed forward in the vicinity of the groove and outward on the lower portion of the whorl; outer lip simple; inner lip incrusted by a thin callus which completely covers the umbilicus, which is continuous with the outer lip; mouth very narrow anteriorly but very broad near the base.

Dimensions: Length, 42mm; width of body-whorl, 35mm.

This species also occurs in the Tejon of Rose Canyon, San Diego County, California, and in the Tejon about ten miles north of Coalinga, California. Its very characteristic shape renders it easy of identification.

Type:—No. 243, Cal. Acad. Sci. Locality 25, Roseburg Quadrangle, Oregon, near the center of Sec. 19, T. 26 S., R. 3 W., on the east bank of Little River at its confluence with the Umpqua, underneath the bridge at that point. Coll., F. M. Anderson.

Named for Mr. Harold Hannibal, whose collections have added greatly to our knowledge of the Tertiary Paleontology of Oregon and Washington.

AMAUROPSIS ANDERSONI, new species.

Plate 12, figures *2a* and *2b*.

Shell of medium size, solid, thick, moderately elevated, smooth except for growth-lines, with five whorls; spire-whorls rounded, their upper half being slightly tabulate, this tabulation better marked on the body-whorl but none of the specimens has this feature as well developed as *Amauropsis alveata* (Conrad). The general dimensions are about the same as in *A. alveata,* though the width in most specimens is slightly greater. The body-whorl is decidedly globose with semilunar mouth; outer lip simple; inner lip slightly incrusted and nearly covering a small narrow umbilicus.

Dimensions: Length, 27mm; width of body-whorl, 25mm.

This species resembles *Amauropsis oviformis* (Gabb) in general outline but its umbilicus is much narrower and its spire-whorls less rounded than in that species.

Type:—No. 244, Cal. Acad. Sci. Locality 25, Roseburg Quadrangle, Oregon, near the center of Sec. 19, T. 26 S., R. 3 W., on the east bank of Little River at its confluence with the Umpqua, underneath the bridge at that point. Coll., Bruce Martin.

Named for Mr. F. M. Anderson, Curator of the Department of Invertebrate Paleontology, California Academy of Sciences, who made extensive collections from the region with which this paper deals.

AMAUROPSIS UMPQUAËNSIS, new species.

Plate 12, figures *3a* and *3b*.

Shell large, solid, thick, much elevated, smooth except for incremental lines, with six or seven whorls; spire-whorls rounded and their upper third somewhat tabulated. This species is much longer than *A. andersoni* Dickerson or *A. alveata* Gabb, and the spire is much higher; body-whorl longer than the width; outer lip simple, with a marked shouldering at linear impressed suture; inner lip covered by a thin callus which nearly covers a small narrow umbilicus.

Dimensions: Length, 41mm; width of body-whorl, 33mm.

Type:—No. 245, Cal. Acad. Sci. Locality 25, Roseburg Quadrangle, Oregon, near the center of Sec. 19, T. 26. S.,

R. 3. W., on the east bank of Little River at its confluence with the Umpqua, underneath the bridge at that point. Coll., Bruce Martin.

Named for the type locality of the species.

CERITHIOPSIS OREGONENSIS, new species.

Plate 11, figures 5*a* and 5*b*.

Shell elongate conic; upper whorls missing; remaining whorls, except the body-whorl, marked by three strong, equally spaced spiral lines of same strength crossed by axial ribs, the crossing being marked by rounded nodes; a very fine thread found between the spiral lines; suture impressed, linear; body-whorl marked by four rows of nodes instead of three, as in the spire-whorls, the last row being weaker than the others; fine threads between these spiral lines; base marked by four or five nodose spiral lines and threads, the spiral lines being smaller than those on rest of whorl; aperture ovate-quadrate, with narrow anterior sinus; outer lip thin; canal twisted.

Dimensions; Length of broken type, 20mm; width of body-whorl, 4.5mm.

This species resembles *C. alternata* Gabb in shape, but its whorls are nearly flat while those of *C. alternata* are decidedly convex. The nodes are much stronger than on *C. alternata*. It differs from *C. excelsus* Dall in that its whorls are nearly flat and its spiral lines less numerous and larger.

Type:—No. 246, Cal. Acad. Sci. Locality 25, Roseburg Quadrangle, Oregon, near the center of Sec. 19, T. 26 S., R. 3 W., on the east bank of Little River at its confluence with the Umpqua, underneath the bridge at that point.

Named for its occurrence in the Eocene of Oregon.

SIPHONALIA CLARKI, new species.

Plate 11, figures 4*a* and 4*b*.

Shell fusiform, with high spire; nine whorls; spire-whorls distinctly shouldered and decorated by about nine rounded nodes which exhibit two apices where two strong spiral lines cross them; space between appressed wavy suture and shoulder concave, and covered by about ten spiral threads; flat space below the suture marked by two strong spiral lines and by eight to ten spiral threads, this area parallel to the axis of the shell;

shoulder located one-third of a whorl length below the suture; body-whorl marked by nodes which vary in strength with different individuals, and shouldered about one-sixth of a whorl-length below the suture; concave space between the suture and the shoulder marked by about twelve spiral threads; area below the shoulder marked by spiral lines of variable strength and by a flat-bottomed sulcus located half the whorl-length below the shoulder; outer lip thin, dentate and lirate within; inner lip covered by a thin callus; umbilicus subimperforate; canal short, twisted to the left.

Dimensions: Length of figured specimens, 40mm; width of body-whorl, 17mm.

This species is easily distinguished from *S. suttcrensis* Dickerson, with which it is associated, by its greater length, by its more pronounced spiral ribbing, and by its greater nodosity.

Type:—No. 247, Cal. Acad. Sci. Locality 25, Roseburg Quadrangle, Oregon, near the center of Sec. 19, T. 26 S., R. 3 W., on the east bank of Little River at its confluence with the Umpqua, underneath the bridge at that point. Coll., F. M. Anderson and Bruce Martin.

Named for Dr. Bruce Clark, Instructor in Invertebrate Paleontology, University of California.

PSEUDOLIVA DILLERI, new species.

Plate 12, figures 1*a*, 1*b*, 1*c*, 1*d*.

Shell biconical; whorls five; spire of moderate height, with conical nodose whorls; suture wavy, indistinct, and bordered by a nodose rim on the succeeding whorl; body-whorl marked by two angulations, both being nodose, but the lower one the stronger; a nearly flat, narrow horizontal space just below the suture rim, this area marked, in addition to spiral lines, by the backward bending lines which mark the former position of a sharp V-shaped posterior sinus; a slightly nodose shoulder terminating this narrow shelf of the body-whorl; from this shoulder the shelf sloping downward to a point a third the length of the body-whorl where another occurs; this second angulation ornamented by prominent rounded tubercules about twelve in number; space between this angulation and the end of the short, slightly-twisted canal marked in its midportion by a deeply impressed groove and by numerous fine spiral lines; a

persistent ribbon-like band, much wider than the space between these spiral lines, about half-way between the tuberculated shoulder and the median groove. This line occurs on most specimens.

Dimensions: Length, 34mm; width of body-whorl, 29mm.

This species can be distinguished from *Pseudoliva volutæformis* Gabb by its greater number of nodes, by the double angulation of the body-whorl, and by the greater strength and abundance of its spiral lines. The spiral lines of this species resemble those of *P. lineata* Gabb, but they are stronger and larger; the tuberculations, however, make it easily distinguishable. This form appears to have been evolved from *P. lineata.*

Type:—No. 248, and cotype, No. 249, Cal. Acad. Sci. Locality 25, Roseburg Quadrangle, Oregon, on Little River at its confluence with the Umpqua, underneath the bridge at that point. Coll., Bruce Martin.

Named in honor of Professor J. S. Diller of the U. S. Geological Survey, whose mapping of the Roseburg Quadrangle made the zonal connection between the Eocene of Oregon and California possible.

EXPLANATION OF PLATE 11.

Fig. 1*a*. *Venericardia planicosta merriami,* new subspecies, x1. This form in the adult lacks the marked radial ribbing of the typical *V. planicosta*. The type specimen which is figured is an extreme case of this lack of radial ribbing. Other adult individuals associated with it show obscure ribs in the umbonal region. A very characteristic form of the Siphonalia sutterensis Zone.

Fig. 1*b*. *Venericardia planicosta merriami,* new subspecies, x1. This is a figure of a young individual which shows about the same type of ribbing as *V. planicosta hornii* (Gabb), its probable progenitor.

Fig. 2*a*. *Pitaria martini,* new species, x1. A side view of the type specimen.

Fig. 2*b*. *Pitaria martini,* new species, x1. Side view of a smaller specimen than the type.

Fig. 2*c*. *Pitaria martini,* new species, x1. View showing hinge of same specimen as Fig. 2*b*.

Fig. 3*a*. *Tivela weaveri,* new species, x1. Side view.

Fig. 3*b*. *Tivela weaveri,* new species, x1. View showing hinge.

Fig. 3*c*. *Tivela weaveri,* new species, x1. Side view of smaller specimen than the type.

Fig. 4*a*. *Siphonalia clarki,* new species, x1. Mouth view.

Fig. 4*b*. *Siphonalia clarki,* new species, x1. Back view.

Fig. 5*a*. *Cerithiopsis oregonensis,* new species, x2. View showing mouth.

Fig. 5b. *Cerithiopsis oregonensis,* new species, x2. Back view.


2b
2c
3c
2a
3b
3a
5b
5a
1b
4a
1a
4b

EXPLANATION OF PLATE 12.

Fig. 1*a*. *Pseudoliva dilleri*, new species, x1. Mouth view.

Fig. 1*b*. *Pseudoliva dilleri*, new species, x1. Back view of same specimen as Fig. 1*a*.

Fig. 1*c*. *Pseudoliva dilleri*, new species, x1. Back view of small individual.

Fig. 1*d*. *Pseudoliva dilleri*, new species, x1. Mouth view of individual figured as Fig. 1*c*.

Fig. 2*a*. *Amauropsis andersoni*, new species, x1. Back view of type specimen.

Fig. 2*b*. *Amauropsis andersoni*, new species x1. Mouth view of type.

Fig. 3*a*. *Amauropsis umpquaënsis*, new species, x1. Mouth view of type.

Fig. 3*b*. *Amauropsis umpquaënsis*, new species, x1. Back view of type.

Fig. 4*a*. *Ancilla (Olivcrato) californica* Cooper, x1. Back view. This species is characteristic of, but not restricted to, the Siphonalia sutterensis Zone.

Fig. 4*b*. *Ancilla (Olivcrato) californica* Cooper, x1. Mouth view.

Fig. 5*a*. *Natica hannibali*, new species, x1. Back view.

Fig. 5*b*. *Natica hannibali*, new species, x1. Mouth view.


1a
2a
3a
1c
2b
1d
3b
4a
1b
4b
5a
5b

PROCEEDINGS

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V

Reptiles and Amphibians of the Islands of the West Coast of North America

BY

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AND

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Assistant Curator of the Department of Herpetology

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December 30, 1914

INTRODUCTORY REMARKS.

In June, 1905, the Academy published a paper entitled "The Reptiles and Amphibians of the Islands of the Pacific Coast of North America from the Farralons to Cape San Lucas and the Revilla Gigedos." The greater portion of the edition of this paper and nearly all the specimens upon which it was based were destroyed in the great fire of April, 1906. In building up a new reptile collection for the Academy effort has been made to replace this material. Specimens of most of the species hitherto reported from these islands are now at hand, and a considerable number of kinds not previously known from various islands will be recorded in the following pages. Owing to the fact that the earlier paper is now out of print, it has been thought best to include in this one all species known from these islands, and in order to make the record more complete we have added the species known from islands in the Gulf of California, as well as those from Isabel, Las Tres Marias, Clipperton and Cocos islands.

We have at present no specimens from any of the islands in the Gulf of California or from Isabel and the Tres Marias islands. An account of the reptiles of the latter islands has been published by Dr. Stejneger in *North American Fauna* No. 14, 1899, pp. 63 to 71. The original records of the reptiles of the islands of the Gulf of California are either given or referred to in a paper on the herpetology of Lower California, published in the *Proceedings of the California Academy of Sciences*, Second Series, Vol. V, pp. 77 to 162.

In this paper the reptilian fauna of thirty-five islands is considered, and some sixty-six species and subspecies are mentioned. The island distribution of these is shown in the following table:

DISTRIBUTION OF ISLAND REPTILES AND AMPHIBIANS

NAME	Farallon	Año Nuevo	San Miguel	Santa Rosa	Santa Cruz	Ana Capa	San Nicolas	Santa Barbara	Santa Catalina	San Clemente	Los Coronados	San Martin	San Geronimo	Guadalupe	San Benito	Cerros	Natividad	Magdalena	Santa Margarita	Socorro	Clarion	Angel de la Guardia	Tiburon	San Pedro Martir	Carmen	San Jose	Espiritu Santo	Isabel	Las Tres Marias	Clipperton	Cocos
Autodax lugubris											+																				
Autodax lugubris farallonensis	+																														
Batrachoseps pacificus			+	+	+																										
Batrachoseps attenuatus									+		+																				
Hyla regilla				+	+				+							+															
Sphaerodactylus pacificus																															+
Phyllodactylus tuberculosus																													+		
Anolis nebulosus																													+		
Anolis townsendi																															+
Ctenosaura teres																												+	+		
Dipsosaurus dorsalis																		+													
Sauromalus hispidus																						+									
Sauromalus sp.																											+				
Callisaurus ventralis																			+			+									
Crotaphytus wislizenii																+		+													
Uta stansburiana					+	+			+	+	+		+			+	+								+		+				
Uta martinensis												+																			
Uta stellata															+																
Uta palmeri																								+							
Uta nigricauda																		+													
Uta microscutata																										+					
Uta lateralis																													+		
Uta auriculata																				+											
Uta clarionensis																					+										
Sceloporus boulengeri																												+			
Sceloporus zosteromus																+		+	+							+					
Sceloporus becki			+																												
Sceloporus biseratus becki				+	+																										
Phrynosoma cerroense																+															
Anniella pulchra											+		+																		
Gerrhonotus caeruleus		+																													
Gerrhonotus scincicauda			+	+	+																										
Gerrhonotus scincicauda ignavus									+		+	+																			

DISTRIBUTION OF ISLAND REPTILES AND AMPHIBIANS—Continued

NAME	Farallon	Año Nuevo	San Miguel	Santa Rosa	Santa Cruz	Ana Capa	San Nicolas	Santa Barbara	Santa Catalina	San Clemente	Los Coronados	San Martin	San Geronimo	Guadalupe	San Benito	Cerros	Natividad	Magdalena	Santa Margarita	Socorro	Clarion	Angel de la Guardia	Tiburon	San Pedro Martir	Carmen	San Jose	Espiritu Santo	Isabel	Las Tres Marias	Clipperton	Cocos
Xantusia riversiana	....	....	....	....	....	....	+	+	?	+	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Verticaria hyperythra beldingi	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	+	....	....	....	....	....	....	....	....	....	....	....	....	....
Verticaria sericea	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....	....	....	....
Cnemidophorus multiscutatus	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	+	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Cnemidophorus rubidus	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	+	....	....	....	....	....	....	....	....	....	....	....	....
Cnemidophorus martyris	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....	....	....	....	....	....
Cnemidophorus mariarum	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....
Cnemidophorus gularis mexicanus	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....	....
Cnemidophorus labialis	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Eumeces skiltonianus	....	....	....	....	....	....	....	....	+	....	+	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Emoia arundelii	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....
Siagonodon humilis	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Boa imperator	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....
Oxybelis acuminatus	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....
Drymobius boddaerti	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....
Bascanion lineatum	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....
Bascanion laterale fuliginosum	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....	....	....	....	....	....	....	....	....	....	....
Bascanion anthonyi	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....	....	....	....	....	....	....	....	....
Hypsiglena ochrorhynchus	....	....	....	....	....	....	....	....	....	....	+	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Pituophis catenifer	....	....	....	....	+	....	....	....	+	....	+	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Pituophis catenifer deserticola	....	....	....	....	....	....	....	....	....	....	....	+	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Drymarchon corais melanurus	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....
Lampropeltis micropholis oligozona	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....
Diplotropis diplotropis	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....
Elaps euryxanthus	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....	....	....	....	....	....	....
Hydrus platurus	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....	....	....
Agkistrodon bilineatus	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....
Crotalus sp.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....
Crotalus oregonus	....	....	....	....	....	....	....	....	+	....	+	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Crotalus exsul	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Crotalus mitchellii	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....	+	....	....	....	....	....	....	....	....	....
Kinosternon integrum	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....
Crocodylus americanus	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	+	....	....

SOUTH FARALLON ISLAND.

Only one kind of salamander is known.

1. **Autodax lugubris farallonensis** Van Denburgh.

Five specimens collected June 15-July 1, 1911, by E. W. Gifford, are Nos. 27335 to 27339.

AÑO NUEVO ISLAND.

This island was visited by Mr. R. H. Beck, July 1, 1909. He collected the following lizard:

1. **Gerrhonotus cæruleus** Wiegmann.

Eight typical specimens (Nos. 14520 to 14527) were secured. These show dark lines between the rows of ventral scales. The dorsal scales are in 16 rows in six specimens, but there are only 14 in Nos. 14520 and 14526.

SAN MIGUEL ISLAND.

One salamander and two lizards are known from this island. We visited San Miguel in April, 1913, but the weather was not favorable for collecting.

1. **Batrachoseps pacificus** Cope.

Two specimens (Nos. 36083 and 36084) were found under a piece of a fallen fence post in a little gully, April 11, 1913. The costal grooves in these specimens are 18 in number. One of these salamanders had a reddish dorsal band similar to that seen in some specimens of *Batrachoseps attenuatus* and *Plethodon cinereus*. The other showed the uniform yellowish brown coloration characteristic of all other known specimens of *B. pacificus*.

2. **Sceloporus becki** Van Denburgh.

We failed to find this lizard on San Miguel Island. The Academy collection contains only the type specimen (No. 4537) collected on San Miguel, by R. H. Beck, March 26, 1903.

3. **Gerrhonotus scincicauda** Skilton.

The only specimen collected by us on San Miguel (No. 36082) was found under a stone April 11, 1913. Its dorsal scales are in 14 rows. The temporal scales and those on the arm and forearm are smooth. The dark ventral lines run along the middles of the scale rows.

SANTA ROSA ISLAND.

During our visit in April, 1911, we secured three species. The *Hyla* had not previously been taken on this island.

1. **Batrachoseps pacificus** Cope.

We failed to find this salamander on Santa Rosa Island, although it is known to occur there.

2. **Hyla regilla** Baird & Girard.

Seventeen specimens (Nos. 36103 to 36119) collected April 12, 1913, add this tree-toad to the known fauna of Santa Rosa Island. They seem to differ in no way from mainland specimens.

3. **Sceloporus biseriatus becki** Van Denburgh.

The 17 specimens (Nos. 36086 to 36102) secured by us show the coloration characteristic of *S. becki*. All these specimens have the frontoparietal separated from the enlarged supraoculars. Femoral pores vary from 14 to 19; being 14 once, 15 eight times, 16 nine times, 17 nine times, 18 five times, and 19 once.

4. **Gerrhonotus scincicauda** Skilton.

We found one specimen (No. 36085) on Santa Rosa Island, April 12, 1913. The dorsals are in 14 rows. The temporals and limb scales are smooth. The ventral dark lines run along the middles of the rows of scales.

SANTA CRUZ ISLAND.

In the few hours we were able to devote to collecting on this island we secured two species which had not been taken there before. Six species are now known from this island.

1. **Batrachoseps pacificus** Cope.

Five specimens (Nos. 36149-36153), were taken April 13, 1913, under old bark and from rotten logs in the vicinity of Pelican Bay. Each has 18 costal folds and shows the coloration typical of this species.

2. **Hyla regilla** Baird & Girard.

We collected 12 specimens (Nos. 36137 to 36148) near Pelican Bay, April 13, 1913. They were found, several together, in cavities in decaying logs, where they probably had retreated for protection from the dry weather of summer.

3. **Uta stansburiana** Baird & Girard.

We did not secure any specimens of *Uta,* although this species is known to occur on this island.

4. **Sceloporus biseriatus becki** Van Denburgh.

Twelve specimens (Nos. 36122 to 36133) were collected April 13, 1913. All these specimens have the frontoparietal separated from the large supraoculars by a complete row of scales and show the same coloration as the Santa Rosa specimens. The femoral pores vary from 14 to 19; being 16 ten times, 17 five times, 15 three times, 18 once, and 19 once.

5. **Gerrhonotus scincicauda** Skilton.

Three specimens (Nos. 36134-36135 and 36136) were collected April 13, 1913. All three are typical of the mainland form. The dorsal scales are in 14 rows. The temporals and the plates on the forearm are smooth, while those on the hind limbs are keeled. The longitudinal lines on the under surface run along the middles of the scale rows.

6. **Pituophis catenifer** (Blainville).

We collected two specimens (Nos. 36120 and 36121) in the vicinity of Pelican Bay, April 13, 1913. No. 36120 has 29 scale rows, gastrosteges 208, urosteges 71, upper labials 8-8, lower labials 13-13, preoculars 1-1, postoculars 3-3, loreals 1-1, temporals 2+3 and 3+3, postgenials shorter, anal plate undivided.

No. 36121 has 29 scale rows, gastrosteges 199, urosteges 54, upper labials 8-9, lower labials 11-11, preoculars 1-1, postoculars 3-3, loreals, 1-1, temporals 3+4 and 4+3, postgenials shorter, anal plate undivided.

With the exception of two rattlesnakes taken on Catalina, these are the only snakes that have ever been collected on any of the California islands, although *Pituophis* also has been seen on Catalina Island.

ANA CAPA ISLAND.

We spent a few hours on Ana Capa Island, April 13, 1913, but found no reptiles. Only one species has been collected there.

1. **Uta stansburiana** Baird & Girard.

This lizard was secured on Ana Capa by Joseph Grinnell, September 4, 1903.

SAN NICOLAS ISLAND.

Mr. Slevin spent five days on San Nicolas Island, November 7-11, 1911. He found only the single species of lizard known from this island.

1. **Xantusia riversiana** Cope.

One hundred and twelve specimens (Nos. 30754 to 30864 and 35793) were secured. These are of various sizes, and show a wide range of coloration. They were found under flat stones just above the high tide line on the beaches. They are very active when disturbed. Careful comparison with our series from San Clemente and Santa Barbara islands has not disclosed any differences.

SANTA BARBARA ISLAND.

This island was visited by Mr. Slevin, October 4, 1912, and a few hours collecting resulted in finding only the one known species.

1. **Xantusia riversiana** Cope.

Twenty-one specimens (Nos. 35567 to 35587) were collected. They were found under rocks near the north end of the island. They seem identical with the specimens from San Nicolas and San Clemente islands.

SANTA CATALINA ISLAND.

One salamander, two lizards and a rattlesnake have been reported from Santa Catalina Island. We now are able to add a *Hyla*, a snake and two other species of lizards.

1. **Batrachoseps attenuatus** (Eschscholtz).

The salamanders of Catalina seem not to differ from those of the mainland.

2. **Hyla regilla** Baird & Girard.

Seventy-six specimens (Nos. 26898 to 26973) were collected near Avalon, July 23 to September 8, 1910, by John I. Carlson, and Mr. Slevin secured 17 (Nos. 35550 to 35566) at the isthmus of the island, September 29 and 30, 1912.

3. **Uta stansburiana** Baird & Girard.

One hundred and sixty-six specimens are before us. Eighty-four of these (Nos. 26812 to 26895) are from the vicinity of Avalon, July 23 to August 26, 1910, while 82 (Nos. 35468 to 35549) were secured near Johnson's Landing, at the north end of the island, September 29 and 30, 1912. Femoral pores in 34 specimens vary from 12 to 16; being 12 ten times, 13 eighteen times, 14 nineteen times, 15 eighteen times, and 16 three times.

4. **Xantusia riversiana** Cope.

Although Mr. Rivers stated that he had received this species from Catalina Island it is very doubtful if it really occurs there. Extended search by Mr. Carlson revealed no specimens, nor was Mr. Slevin more successful in finding it on this island, and no other collector has secured it there.

5. **Gerrhonotus scincicauda ignavus** Van Denburgh.

A single specimen (No. 26896) was collected at Avalon, August 13, 1910. There are 14 longitudinal rows of dorsal scales, and the dark lines on the belly run along the middles of the scales. Owing to the fact that this specimen is quite young, the temporals are not keeled, but the caudal keeling is typical of this subspecies.

6. **Eumeces skiltonianus** (Baird & Girard).

A single young individual (C. A. S. No. 26897) taken by Mr. Carlson at Avalon, August 1, 1910, establishes the first record of this species on Catalina Island.

7. **Pituophis catenifer** (Blainville).

Mr. Charles L. Camp has informed us that he found a good-sized gopher snake at the isthmus of the island, July 3, 1910, but that it escaped. We know of no specimen from Catalina in any museum.

8. **Crotalus oregonus** Holbrook.

The presence of rattlesnakes on Catalina was first recorded by Yarrow from a specimen taken there by Mr. Schumacher in 1876. This record has remained unconfirmed. Through the kindness of Dr. Grinnell and Mr. Charles L. Camp we

are now able to record a second specimen. This is No. 4323 in the collection of the Museum of Vertebrate Zoology, University of California, and was found by Mr. Camp at an elevation of about 25 feet near the isthmus of the island, July 7, 1910. It is a male with scales in 23 rows, gastrosteges 169, urosteges 23, supralabials 15-15, infralabials 14-14, preoculars 2-2, and postoculars 3-3.

SAN CLEMENTE ISLAND.

Mr. Slevin collected on San Clemente Island three days in October, 1912. He secured only the two kinds of lizards previously known from this island.

1. **Uta stansburiana** Baird & Girard.

Eighty-three specimens (Nos. 35710 to 35792) were secured. They seem not to differ from mainland lizards of this species.

2. **Xantusia riversiana** Cope.

One hundred and twenty-two of these lizards were collected on San Clemente Island by Mr. Slevin October 15 to 17, 1912. They were taken in the vicinity of Mosquito Harbor, and were found under stones near the beach and on the plateau several hundred feet above. There appears to be no difference between these lizards and the Xantusias of San Nicolas and Santa Barbara islands.

LOS CORONADOS.

Mr. R. H. Beck visited these islands in 1908, and collected several species not previously recorded.

1. **Batrachoseps attenuatus** (Eschscholtz).

Fifty-five (Nos. 13477 to 13531) were collected on East Coronado Island, February 15, 1908, and five (Nos. 13604 to 13608) are labeled merely Coronado Islands. They seem identical with specimens from the mainland. Costal grooves in 38 specimens are 18 on each side except in specimens Nos. 13509 and 13512, which have 19.

2. **Autodax lugubris** (Hallowell).

Two specimens (Nos. 13609 and 13610) labeled Coronado Islands were collected February 22, 1908. Their costal grooves are 12 on each side.

3. **Uta stansburiana** Baird & Girard.

Two specimens (13449 and 13450) were taken on East Coronado Island, February 15, 1908, and three others (13532 to 13534) are labeled South Coronado, April 9, 1908. Femoral pores vary from 10 to 15; being 10 once, 13 three times, 14 four times, and 15 twice.

4. **Anniella pulchra** Gray.

This species has not been recorded from any of the islands of the Pacific Coast. We now have at hand 10 specimens from the Coronado Islands. Nos. 13579 to 13582 were collected on South Coronado, April 6-7, 1908. Nos. 13471 to 13475 were secured on East Coronado, February 15, 1908. No. 13601 is labeled merely Coronado Islands, February 22, 1908.

5. **Gerrhonotus scincicauda ignavus** Van Denburgh.

This lizard was collected on North, South and East Coronado islands. From North Coronado we have four (Nos. 13444 to 13447) collected April 6-8, 1908. Twenty-four (Nos. 13535 to 13559) were collected on South Coronado, April 6-11, 1908. Eleven (Nos. 13451 to 13461) were taken on East Coronado, February 15, 1908. Five (Nos. 13590 to 13594) labeled merely Coronado Islands, were caught February 22, 1908.

All but No. 13590 have keeled temporals, and all have caudal keeling typical of *G. s. ignavus*. The dark ventral lines are along the middles of the scales in all 45 specimens. The longitudinal rows of dorsals are in 14$\frac{2}{2}$ rows in two specimens, 14 rows in 31, 12$\frac{2}{2}$ rows in 10, and 12 in two specimens.

6. **Eumeces skiltonianus** (Baird & Girard).

The collection includes 35 specimens of this skink. Only one of these (No. 13448) is from North Coronado Island, April 8, 1908. It has 26 rows of scales around the body. Twenty-five (Nos. 13560 to 13575 and 13595 to 13600) are from South Coronado, April 6-7, 1908. The scales around the middle of the body in 17 specimens counted are 24 in five and 26 in twelve. Nine (Nos. 13462 to 13470) were secured on East Coronado Island, February 15, 1908. The scales are in 24 rows in four and 26 in five of these specimens. The number of scales in a row along the back, from the head to a line con-

necting the posterior surfaces of the thighs, in 34 specimens from all the islands, varies from 55 to 61; being 55 three times, 56 four times, 57 five times, 58 eleven times, 59 five times, 60 five times, and 61 once.

7. **Hypsiglena ochrorhynchus** Cope.

A single specimen (No. 13602) collected February 22, 1908, is labeled Coronado Islands. The scales are in 21 rows, gastrosteges 178, anal divided, urosteges 44, supralabials 8-8, infralabials 10-10, preoculars 2-2, postoculars 2-2, loreal 1-1, temporals 1+2-1+2, genials equal.

8. **Pituophis catenifer** (Blainville).

Two specimens from South Coronado Island are at hand.

No. 13588, April 6, 1908, has 31 scale rows, 231 gastrosteges, 65 urosteges, supralabials 8-8, infraliabials 12-12, preoculars 2-2, postoculars 3-3, loreal 1-1, anterior genials longer.

No. 13589, April 11, 1908, has 35 scale rows, 229 gastrosteges, 71 urosteges, supralabials 9-9, infralabials 13-13, preoculars 2-2, postoculars, 3-3, loreal 1-1, temporals 3+3-3+3, anterior genials longer.

9. **Crotalus oregonus** Holbrook.

We have seven rattlesnakes of this species from these islands. Nos. 13583 to 13587 were collected on South Coronado, April 6-11, 1908. No. 13476 was secured on East Coronado, February 15, 1908, No. 13603 is labeled merely Coronado Islands, February 22, 1908. No. 13586 contains the remains of a lizard (*Eumeces*) which it had eaten. Variation in scales is shown in the following table:

SCALE COUNTS IN *CROTALUS OREGONUS.*

No.	Scales	Gastro steges	Uro steges	Supra labials	Infra labials	Pre oculars	Post oculars	Loreal
13476	25	171	19(1÷)	13—13	14—14	2—2	3—3	1—1
13583	25	177	19(9÷)	15—14	15—15	2—2	3—3	1—1
13584	27	176	20(1÷)	14—15	15—15	2—2	3—3	1—1
13585	29	171	18(7÷)	15—16	16—18	2—2	3—3	1—1
13586	25	172	15(1÷)	12—14	15—14	2—2	3—2	0—0
13587	25	168	22(4÷)	16—15	16—16	2—2	3—3	1—1
13603	25	179	17(1÷)	15—15	15—15	2—2	3—3	1—1

SAN MARTIN ISLAND.

1. **Uta martinensis** Van Denburgh.

Four specimens (Nos. 8673 to 8676) of this large-scaled lizard were collected on San Martin, July 11, 1905. None of these has the fifth toe reaching beyond the tip of the second, as in the original specimen. Femoral pores in No. 8674 are 13-14, and in 8676 they are 12-14. These lizards were secured on a sand beach near the north end of the island.

2. **Gerrhonotus scincicauda ignavus** Van Denburgh.

Our collection contains the type specimen and one other (No. 8677) collected July 11, 1905. The dorsals are in 14 rows. The temporal and caudal scales, as well as those on the limbs, are strongly keeled. The dark lines on the belly run along the middles of the rows of scales.

3. **Pituophis catenifer deserticola** Stejneger.

One specimen (No. 8678) collected on the north end of San Martin Island, July 11, 1905, is as brightly colored as specimens from the desert regions of California, Nevada and Arizona. The scales are in 31 rows, gastrosteges 236, urosteges 76, supralabials 8-9, infralabials 13-13.

SAN GERONIMO ISLAND.

We have secured two kinds of lizards from this island. Neither has been recorded previously.

1. **Uta stansburiana** Baird & Girard.

The collection includes 37 specimens (Nos. 8679 to 8714 and 8717) collected July 13, 1905. They seem not to differ appreciably from mainland specimens of this species. The femoral pores in 34 of these lizards vary from 12 to 16; being 12 eighteen times, 13 twenty-eight times, 14 fifteen times, 15 five times, and 16 twice.

2. **Anniella pulchra** Gray.

Two specimens (Nos. 8715-8716) of this footless lizard were secured July 13, 1905. One was found under a stone and the other was dug out of the soft earth under a bush.

GUADALUPE ISLAND.

No reptiles or amphibians have been collected on Guadalupe Island. The only information we have been able to secure as to their occurrence on this island is contained in a paper by Edward L. Greene, published in Bulletin No. 4 of the California Academy of Sciences, p. 220. He writes:

"Of reptiles I met with only two or three small lizards. In the moist parts of the plateau are plenty of shallow and tepid pools, fed by springs, but not even a tadpole was visible; and both soldiers and seamen assured me that none of the toad or frog race were ever seen or heard on Guadalupe. Most other islands off the coast of Mexico are commonly reported to be alive with snakes; but no one charges this remoter and more oceanic pile with harboring serpents of any sort; and during my seven days of incessant rambling and climbing I did not see one."

SAN BENITO ISLANDS.

There are three islands in this group—West, Middle and East San Benito. Only one species of lizard has been taken here. It occurs on all three islands.

1. **Uta stellata** Van Denburgh.

The type probably came from West San Benito Island. We now have 100 specimens (Nos. 8718 to 8817) collected on this island by Mr. Slevin, July 14, 1905; four (Nos. 8834 to 8837) taken on Middle San Benito, July 15, 1905; and 16 (Nos. 8818 to 8833) secured on East San Benito, July 15, 1905. Femoral pores in 50 specimens from West San Benito vary from 12 to 18; being 12 once, 13 seven times, 14 twenty-three times, 15 twenty-eight times, 16 eighteen times, 17 four times, and 18 three times. In 12 specimens from East Benito the femoral pores vary from 13 to 16; being 13 four times, 14 seven times, 15 nine times, 16 four times. In the four lizards from Middle San Benito Island the pores are 15 five times and 16 three times.

This small scaled member of the *Uta stansburiana* group is a ground dwelling species. It was most abundant on the lower portions of the islands.

CERROS ISLAND.

Mr. Slevin spent one day on Cerros Island. Owing probably to the shortness of his visit, he failed to find a number of species which have been recorded by others. On the other hand, he secured a lizard and a snake not previously taken on Cerros, so that 10 species are now known to live there.

1. **Hyla regilla** Baird & Girard.

Mr. Slevin did not secure this tree-toad, which has been reported by Dr. Streets and Mr. Belding.

2. **Crotaphytus wislizenii** Baird & Girard.

The Leopard Lizard is represented in our Cerros collection by two specimens (Nos. 8843 and 8844) taken by Mr. Slevin, July 18, 1905, in a dry wash in the south end of the island. No. 8843 has femoral pores 24-25, and No. 8844 has 23-22 pores.

3. **Uta stansburiana** Baird & Girard.

Mr. Slevin secured eleven Utas which seem typical of this species. These are Nos. 8845 to 8850, 8858 to 8859, and 8861 to 8863. Femoral pores in six of these vary from 11 to 15; being 11 once, 12 once, 13 three times, 14 four times, and 15 three times. This lizard had been taken on Cerros by both Dr. Streets and Mr. Belding.

4. **Sceloporus zosteromus** Cope.

Three specimens (Nos. 8842, 8856 and 8857) taken by Mr. Slevin, July 18, 1905, confirm Mr. Belding's record of this lizard. Femoral pores are 16-16, 17-18, 16-16.

5. **Phynosoma cerroense** Stejneger.

This horned toad was not found by Mr. Slevin. It is known from a single specimen taken by Mr. Belding.

6. **Verticaria hyperythra beldingi** (Stejneger).

This lizard also was not secured here by Mr. Slevin.

7. **Cnemidophorus multiscutatus** Cope.

Cerros is the type locality of this form. Nine whiptails (Nos. 8838 to 8841 and 8851 to 8855) were taken by Mr. Slevin. Femoral pores in eight of these vary from 18 to 22; being 18 twice, 19 three times, 20 five times, 21 five times, and 22 once.

8. **Cnemidophorus labialis** Stejneger.

We have no specimens of this species.

9. **Siagonodon humilis** (Baird & Girard).

No. 8860 is a dried specimen of this worm snake which was found dead on the sand in a dry wash, July 18, 1905.

10. **Crotalus exsul** Garman.

We have received no rattlesnakes from Cerros Island.

NATIVIDAD ISLAND.

We have two kinds of lizards secured by Mr. Slevin during a visit of a few hours, July 19, 1905.

1. **Uta stansburiana** Baird & Girard.

The collection includes 46 specimens (Nos. 8887 to 8932) of this *Uta*. The femoral pores in 40 specimens vary from 12 to 17; being 12 once, 13 six times, 14 sixteen times, 15 thirty-one times, 16 twenty times, and 17 six times.

2. **Cnemidophorus multiscutatus** Cope.

Twenty-three whiptails (Nos. 8864 to 8886) taken seem not to differ from those secured on Cerros Island. They were abundant about the deserted nesting burrows of sea birds. Femoral pores vary from 16 to 21; being 16 four times, 17 eight times, 18 nine times, 19 fifteen times, 20 six times, and 21 four times.

MAGDALENA ISLAND.

We have no additional material from this island. The following species have been recorded.

1. **Dipsosaurus dorsalis** Baird & Girard.
2. **Crotaphytus wislizenii** Baird & Girard.
3. **Uta nigricauda** Cope.
4. **Sceloporus zosteromus** Cope.
5. **Verticaria hyperthra beldingi** (Stejneger).
6. **Cnemidophorus rubidus** (Cope).

SANTA MARGARITA ISLAND.

We have nothing new to record regarding the reptiles of Santa Margarita. Five kinds have been reported.

1. **Callisaurus ventralis** (Hallowell).
2. **Sceloporus zosteromus** Cope.
3. **Cnemidophorus rubidus** Cope.
4. **Bascanion laterale fuliginosum** (Cope).
5. **Crotalus mitchellii** Cope.

SAN BENEDICTO ISLAND.

Mr. Slevin spent several hours on this island, July 26, 1905, with four other members of the expedition. No reptiles were seen by any member of the party, although careful search was made.

SOCORRO ISLAND.

1. **Uta auriculata** Cope.

This *Uta* remains the only reptile known from Socorro Island, except the green turtle which breeds here in numbers. Ninety-two specimens (Nos. 8933 to 9024) collected by Mr. Slevin, July 27-28, 1905, are now before us. In life their bright blue coloration makes them conspicuous on the black lava. The femoral pores are small and difficult to count. In 20 specimens they vary in number from 10 to 13; being 10 eight times, 11 eighteen time, 12 eleven times, and 13 three times.

CLARION ISLAND.

We now have no specimens from this island, the great fire of 1906 having destroyed those we had. The two species known from Clarion are a lizard and a snake:

1. **Uta clarionensis** Townsend.
2. **Bascanion anthonyi** Stejneger.

ANGEL DE LA GUARDIA ISLAND.

Three species of reptiles have been recorded from this island.

1. **Callisaurus ventralis** (Hallowell).

Callisaurus dracontoides, TOWNSEND, Proc. U. S. Nat. Mus., XIII, 1890, p. 144.

Callisaurus ventralis, VAN DENBURGH, Proc. Cal. Acad. Sci., (2), V, 1895, p. 98.

Townsend has recorded the presence of this lizard on Angel Island, Gulf of California.

2. **Sauromalus hispidus** Stejneger.

Sauromalus ater, STREETS, Bull. U. S. Nat. Mus., No. 7, 1877, p. 36; TOWNSEND, Proc. U. S. Nat. Mus., XIII, 1890, p. 144.

Sauromalus hispidus STEJNEGER, Proc. U. S. Nat. Mus., XIV, 1891, p. 409.

Dr. Stejneger has described this species from four specimens collected by Dr. Streets and Mr. Townsend on Angel Island. Dr. Streets states that these lizards are abundant on the island.

3. **Crotalus mitchellii** Cope.

Crotalus pyrrhus STREETS, Bull. U. S. Nat. Mus., No. 7, 1877, p. 39; TOWNSEND, Proc. U. S. Nat. Mus., XIII, 1890, p. 144.

Crotalus mitchellii, VAN DENBURGH, Proc. Cal. Acad. Sci., (2), V, 159.

Dr. Streets was the first to report the presence of this rattlesnake on Angel Island. Mr. Townsend afterward collected one there.

TIBURON ISLAND.

We know of only one record of a reptile having been taken on Tiburon Island. Doubtless many species occur there.

1. **Elaps euryxanthus** Kennicott.

Dr. Streets has reported this coral snake from this island. (Bull. U. S. Nat. Mus., No. 7, 1877, p. 40).

SAN PEDRO MARTIR ISLAND.

Two species of lizards have been described by Dr. Stejneger as peculiar to this island.

1. **Uta palmeri** Stejneger.

Uta palmeri STEJNEGER, N. A. Fauna, No. 3, 1890, p. 106; VAN DENBURGH, Proc. Cal. Acad. Sci., (2), V, 1895, p. 106.

This species is allied to *Uta stansburiana.*

2. **Cnemidophorus martyris** Stejneger.

Cnemidophorus martyris STEJNEGER, Proc. U. S. Nat. Mus., XIV, 1891, p. 407; COPE, Trans. Am. Philos. Soc., XVII, 1, 1892, p. 36; VAN DENBURGH, Proc. Cal. Acad. Sci., (2), V, p. 125.

Two specimens were collected by Dr. Edward Palmer. They seem most closely allied to *C. melanostethus.*

CARMEN ISLAND.

Only one lizard has been reported from this island.

1. **Uta stansburiana** Baird & Girard.

Uta elegans, TOWNSEND, Proc. U. S. Nat. Mus., XIII, 1890, p. 144.

Uta stansburiana, VAN DENBURGH, Proc. Cal. Acad. Sci., (2), V, 1895, p. 104.

Mr. Townsend collected this species on Carmen Island.

SAN JOSE ISLAND.

The following three kinds of lizards were collected by W. E. Bryant on San Jose Island in April and May, 1892.

1. **Uta microscutata** Van Denburgh.

Uta microscutata VAN DENBURGH, Proc. Cal. Acad. Sci., (2), V, 1895, p. 106.

Two specimens were secured.

2. **Sceloporus zosteromus** Cope.

Sceloporus zosteromus, VAN DENBURGH, Proc. Cal. Acad. Sci., (2), V, 1895, pp. 109, 110.

Two were taken.

3. **Verticaria sericea** Van Denburgh.

Verticaria sericea VAN DENBURGH, Proc. Cal. Acad. Sci., (2), V, 1895, p. 132.

This species is known only from the type specimen.

ESPIRITU SANTO ISLAND.

Two kinds of lizards are known to occur here, and a sea snake has been taken near this island.

1. **Sauromalus** sp?

Sauromalus ater, BELDING, West Am. Sci., III, 1887, pp. 96, 97.

Sauromalus sp?, STEJNEGER, Proc. U. S. Nat. Mus., XIV, 1891, p. 411.

A medium-sized *Sauromalus* collected by Mr. Belding on this island is No. 12633 of the U. S. National Museum collection. Its specific identity is not definitely known.

2. **Uta stansburiana** Baird & Girard.

Uta stansburiana, VAN DENBURGH, Proc. Cal. Acad. Sci., (2), V, 1895, p. 105.

Two specimens were collected by Mr. W. E. Bryant in April, 1892.

3. **Hydrus platurus** (Linnæus).

Hydrus platurus, MOCQUARD, Nouv. Arch. du Mus., (4), I, p. 331.

Mocquard says:

Deux spécimens ont été capturés dan le golfe de Californie, au large de l' île Espiritu Santo.

ISABEL ISLAND.

The following list is taken from Stejneger's paper on the Tres Marias. We have no specimens from this island.

1. **Ctenosaura teres** (Harlan).
2. **Sceloporus boulengeri** Stejneger.
3. **Cnemidophorus gularis mexicanus** Peters.

LAS TRES MARIAS.

We have no specimens from these islands. Stejneger, in the *North American Fauna,* No. 14, 1899, pp. 63-71, records 16 species of land reptiles. One of these, *Diplotropis diplotropis* (Günther), is known only from specimens labeled merely the Tres Marias. The other species have been taken on the three islands, as follows:

MARIA MADRE ISLAND.

1. **Kinosternon integrum** Leconte.
2. **Crocodylus americanus** Laur.
3. **Phyllodactylus tuberculosus** Wiegmann.
4. **Anolis nebulosus** Wiegmann.
5. **Ctenosaura teres** (Harlan).
6. **Uta lateralis** Boulenger.
7. **Cnemidophorus mariarum** Günther.
8. **Boa imperator** Daudin.
9. **Oxybelis acuminatus** (Wied).
10. **Drymobius boddaerti** (Seetzen).
11. **Bascanion lineatum** Bocourt.
12. **Drymarchon corais melanurus** (Dum. & Bibron).
13. **Lampropeltis micropholis oligozona** (Bocourt).
14. **Agkistrodon bilineatus** (Günther).

MARIA CLEOFA ISLAND.

1. **Phyllodactylus tuberculosus** Wiegmann.
2. **Anolis nebulosus** Wiegmann.
3. **Ctenosaura teres** (Harlan).
4. **Cnemidophorus mariarum** Günther.

MARIA MAGDALENA ISLAND.

1. **Crocodylus americanus** Laur.
2. **Anolis nebulosus** Wiegmann.
3. **Cnemidophorus mariarum** Günther.
4. **Drymobius boddaerti** (Seetzen).
5. **Crotalus** sp?

CLIPPERTON ISLAND.

Clipperton Island is an atoll about three miles long, at one end of which may be seen a large black rock known as Clipperton Rock. The following species seems to be the only land reptile known from Clipperton Island.

1. **Emoia arundelii** (Garman).

Lygosoma arundelii GARMAN, Proc. N. Eng. Zool. Club, I, 1899, p. 61; HELLER, Proc. Wash. Acad. Sci., Vol. V, 1903, p. 97.

Sixty-five specimens (Nos. 9025-9089) were collected on Clipperton Rock, August 10, 1905. These lizards appear to be more abundant on Clipperton Rock than elsewhere on the island. The following color description was taken from a living specimen, now number 9054, of the Academy collection:

Back very dark brown with a fairly distinct grayish stripe running from tip of snout to base of tail, gular region a little darker than belly, which is dull slate; under surface of hind legs yellowish.

We have not compared these lizards with *E. cyanura*.

The scales around the middle of the body were counted in 38 specimens and found to be in 28 rows in all. The scales in a row down the middle of the back from the base of the head to a line joining the posterior surface of the thighs vary from 51 to 56; being 51 twice, 52 six times, 53 ten times, 54 eight times, 55 eight times, and 56 four times.

COCOS ISLAND.

Two species of lizards from this island have been described.

1. **Sphærodactylus pacificus** Stejneger.

Sphærodactylus pacificus STEJNEGER, Proc. Biol. Sci. Wash., Vol. XVI, 1903, p. 3.

This species was described by Dr. Stejneger from five specimens collected in 1902 by Prof. Biolley, naturalist of the Museo Nacional, San José, Costa Rica. Although a careful search was made during a week's stay, September 5-12, 1905, by the Academy's Galapagos expedition, no specimens of this gecko were obtained.

2. **Anolis townsendi** Stejneger.

Anolis townsendi Stejneger, Bull. Mus. Comp. Zool., Vol. XXXVI, 1900, p. 163; Heller, Proc. Wash. Acad. Sci., Vol. V, 1903, p. 95.

One hundred and sixty specimens (Nos. 9090-9249) were collected in the vicinity of Wafer and Chatham bays, September 5-12, 1905. These lizards were abundant on the vines and trees along the water courses. When approached they would jump several inches from leaf to leaf, and when alighting would always turn so as to face the ground. The males at this season were seen displaying the gular pouch.

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VI

The Pocket Gopher of the Boreal Zone on San Jacinto Peak

BY

J. GRINNELL and H. S. SWARTH.*

In our report upon the birds and mammals of the San Jacinto area of southern California (Univ. Calif. Publ. Zool., Vol. 10, 1913, pp. 354-355) the twelve specimens of pocket gophers at that time available from the Boreal zone on San Jacinto Peak were referred to *Thomomys altivallis* Rhoads. That series contained not one adult male, and the possibility was suggested that, upon proper comparisons, differences would be found to exist whereby the species of San Jacinto Peak could be distinguished from that of the San Bernardino Mountains (*altivallis*). It will be recalled that the San Jacinto and San Bernardino mountain masses are separated only by the narrow, though deep, San Gorgonio Pass. The latter is cut to such a depth as to be traversed by a tongue of the Lower Sonoran zone, yet so steep are the confining walls that the nearest limits of the boreal areas of the separated mountain masses are only about seventeen miles apart.

In order to clear up the relationships of the San Jacinto gopher, opportunity was taken by the junior author, in September, 1914, to revisit San Jacinto Peak, with the result that seven more specimens were obtained, four of which are adult males. With this additional material we now find good grounds for nomenclatural separation of the San Jacinto and San Bernardino mountain gophers, and also for further discussion of relationships.

*Contributed from the Museum of Vertebrate Zoology of the University of California.

December 30, 1914

Thomomys jacinteus, new species.

San Jacinto Gopher

Type.—Male, adult; No. 21235, Mus. Vert. Zool.; Round Valley, 9000 feet altitude, San Jacinto Mountains, Riverside County, California; September 15, 1914; collected by H. S. Swarth; orig. No. 10012.

Diagnosis.—A *Thomomys* of the *alpinus* group of species. Size medium; coloration dark; skull long and narrow, but faintly ridged, and with relatively straight top in lateral profile.

Material.—Nineteen skins-with-skulls from San Jacinto Peak: Nine (Nos. 21229-21235, 1761, 1762) from Round Valley, 9000 feet altitude; ten (Nos. 2188-2197) from Tahquitz Valley, 8000 feet altitude. Of these, nine are obviously young; seven are males, twelve are females.

Comparisons.—As compared with topotypes of *Thomomys altivallis* Rhoads, its nearest relative geographically, the new species is decidedly smaller in general size (see accompanying tables of measurements), the tone of coloration is slightly browner, there is more or less white about the face, the whole skull is much narrower (except for interorbital constriction), there is less of angulation and ridging, the nasals are shorter, and the dorsal outline is more nearly straight in lateral profile. From *Thomomys neglectus* Bailey, from the San Gabriel Mountains, as originally described (Proc. Biol. Soc. Wash., Vol. 27, 1914, p. 117), *jacinteus* evidently differs notably in much less blackish coloration, in presence of more or less white about the face, and in less elongated and straight-topped skull. From topotypes of *Thomomys alpinus* Merriam, from the Mount Whitney region, *jacinteus* differs in decidedly browner and darker, less grayish, coloration, in much less squarely spreading zygomatic arches, in narrower braincase, and in shorter and posteriorly less attenuated nasals. From the species of gopher on the immediately adjacent lower slopes of San Jacinto Peak (*T. nigricans* Rhoads, of Upper Sonoran and low Transition), *jacinteus* differs in decidedly larger general size and notably larger ears and front feet, in

much less reddish-brown tone of coloration, in more or less white marking about the face, in heavier dentition, in larger and especially more elongated auditory bullæ, in wider interorbital constriction, in less widely spreading zygomatic arches, and in more nearly straight dorsal outline of skull in lateral profile.

Taking all characters into consideration, there appear to be more in common between *jacinteus* and *alpinus* than between *jacinteus* and *altivallis*. Out of the entire series of *jacinteus*, both adults and young, eleven have much white on chin and lining of cheek-pouches, as in *alpinus*; the rest all show white in lining of cheek-pouches, at least. *Altivallis* has a blackish brown face, rarely showing white, even within the cheek-pouches.

Relationships and Ecology.—The habitats of the several species of *Thomomys* occurring in the San Jacinto Mountains seem to be constituted mainly by the several valleys comprising areas of varying size throughout the range. Thomas (or Hemet), Strawberry, Tahquitz, and Round valleys are the more important of the stretches of comparatively open and level country of the higher parts of the mountains; and while gophers also occur in limited numbers along some of the streams connecting these sections, as well as on many of the dry and rather open pine-covered ridges, still the meadowlands in each of these valleys may be considered as the centers of abundance and radial dispersal of the gophers of these mountains. The densely brush-covered slopes surrounding the lower valleys offer poor inducements to the species, and the animals are seldom found in such places.

The three higher valleys of San Jacinto Peak, Strawberry Valley at 6000 feet, Tahquitz Valley at 8000 feet, and Round Valley at 9000 feet, form a series of terraces on the sides of the mountain. In these mountain valleys the soil is deep and rich, in many places supporting a dense growth of grasses, and sometimes so saturated with water as to form acres of wet bog, altogether making most favorable surroundings for gophers. In striking contrast, the valleys' edges are sharply defined by steep, rocky slopes, these in the higher portions of the range frequently forming series of bare cliffs, in the lower parts steep, gravelly hillsides, densely covered with chaparral.

Many portions of these breaks in the topography are sufficiently marked to suggest their actual service as physical barriers to the dispersal of animals having the sedentary habits of gophers. Especially is this the case between Strawberry and Tahquitz valleys, where lies the dividing line between *nigricans* and *jacinteus*. It will be noted that Tahquitz and Round valleys, as well as the country lying directly between, the entire habitat of *jacinteus* in fact, is on the eastern slope of San Jacinto Peak, with all drainage toward the desert. Strawberry Valley, together with the rest of the habitat of *nigricans* in these mountains, is west of the divide. There are no streams connecting the higher valleys with Strawberry Valley and the slopes to the westward, streams which with their narrow margins of favorable surroundings would offer means of dispersal for these animals. Also the slopes intervening are so steep and rocky as apparently to preclude the possibility of uninterrupted distribution without some such passage ways (see Univ. Calif. Publ. Zool., Vol. 10, plate 8, fig. 1).

This latter condition also prevails on the eastern side of the mountain, where the series of tremendous, rocky precipices descending abruptly to the desert forms an effective barrier, in all probability extending from the habitat of the boreal *jacinteus* to that of the Lower Sonoran *perpallidus* of the floor of the desert below. So altogether it seems probable that *Thomomys jacinteus* is absolutely separated from those forms geographically nearest to it by the physical conditions surrounding its habitat.

Between Tahquitz and Round valleys there is no abrupt break. Although at the eastern edge of Round Valley there is nearly as steep and rocky a cliff as between Tahquitz and Strawberry valleys, the approach from Tahquitz Valley to Hidden Lake, and thence to Round Valley, is gradual, and gopher sign was seen continuously over the whole distance. In accounting for the occurrence of *nigricans* in Strawberry Valley, in common with the lower Thomas Valley and the country to the southward, there is no difficulty, for while Strawberry Valley occupies a sharply defined terrace, with steep slopes below, the connecting streams with their adjacent congenial margins are probably sufficient to explain the general dispersal of this species of gopher.

As the structural peculiarities of *jacinteus* point to close affinities with other boreal species from distant mountains, rather than with the geographically nearer low-zone species of the same mountain mass, there is, of course, no need for invoking a theory of isolation from *nigricans* to account for the occurrence of the former on San Jacinto Peak. It is, however, of decided interest to note the probable existence of associational barriers to the dispersal of an animal with the habits of the gopher, along the exact line where division between *jacinteus* and *nigricans* appears to be. While these barriers may have had nothing to do with the origin of either species, they may well be the sole prevention of the wider dispersal of either one of them, which, if it had been freely possible, might have resulted in competitive displacement of the other.

The summer of 1914 had been an unusually dry one in the San Jacinto Mountains, where this season of the year is generally accompanied by frequent thunder showers; and in the lower parts of the range the dryness had the effect of entirely stopping the gophers from any active digging. In Strawberry Valley, during two weeks, no freshly thrown-out earth was seen, though *Thomomys nigricans* is an abundant inhabitant of the valley, and old mounds could be observed everywhere. It was evident, however, that the cessation of digging activities by the animals was by no means an indication that they were in a dormant condition similar to hibernation. A house cat belonging to an acquaintance in the camp caught gophers frequently, sometimes two in a night.

Trapping here was not promising, however, for there was no way of telling which entrances were in use; so it was a relief to find that conditions were somewhat different in the higher valleys where *jacinteus* occurs. The several large meadows occupying the centers of Tahquitz and Round valleys are so saturated with water that even in a dry summer parts of them remain boggy. About these wet meadows the gophers were most abundant. No trapping was done in Tahquitz Valley during the visit of September, 1914, and but a cursory investigation of conditions was made; but several fresh mounds were noted near the edges of the meadow and on the adjacent dry ridges.

In Round Valley, September 13, 14 and 15, gophers were found to be working actively, though in a rather limited area. The meadow here is about two hundred yards across, and about a quarter of a mile in length, and the gophers occupied a narrow belt surrounding this area. They worked down toward the center as far as the water permitted, but not far into the dry woods of the higher surrounding ridges. Fresh mounds were also noted along the margins of the stream flowing out of the valley, at various points along this and other small streams between Round Valley and Hidden Lake, and between Hidden Lake and Tahquitz Valley. These fresh workings, however, were always near water, where there was a little green growth. No gopher sign was noted on the steep slopes between Round Valley and the summit of San Jacinto Peak. Here, as elsewhere, it seemed evident that such stony ground is impassable to the animals.

The burrows in Round Valley were of noticeably small size, a condition possibly produced by the dryness and consequent hardness of the ground. The occupied holes were all in grassy areas, and the green grass seemed to be the principal food plant sought. Cut grass was found in several of the holes. Of the seven animals taken at this point, four were caught in the middle of the day. The other three may also have been captured after daylight, as the traps were not inspected until some time after dawn. Evidently they were working actively during the day.

MEASUREMENTS IN MILLIMETERS OF NINE ADULTS OF *THOMOMYS ALTIVALLIS*

Mus. No.	Sex	Total length	Tail vertebræ	Hind foot	Occipito-nasal length or cranium	Zygomatic width	Mastoid width	Inter-orbital constriction	Length of nasals
4546	♂	267	85	36	48.6	30.2	24.8	6.0	17.5
4543	♂	256	80	36	48.2	30.7	25.0	6.3	16.8
4601	♂	265	83	36	47.8	31.6	25.2	5.9	17.0
4599	♂	249	82	34	47.2	28.4	22.8	6.8	17.7
4592	♀	232	75	31	42.7	25.7	21.8	6.6	15.7
4568	♀	215	73	31	40.8	25.7	20.6	7.0	14.2
4587	♀	223	63	30	41.1	25.9	20.6	6.9	14.1
4554	♀	203	65	31	39.5	24.9	20.0	7.0	12.6
4593	♀	219	62	32	38.4	22.4	19.7	6.8	13.0

MEASUREMENTS IN MILLIMETERS OF NINE ADULTS OF *THOMOMYS JACINTEUS*

Mus. No.	Sex	Total length	Tail vertebræ	Hind foot	Occipito-nasal length of cranium (1)	Zygomatic width	Mastoid width (2)	Inter-orbital constriction	Length of nasals
21235	♂	240	82	32	43.5	25.0	20.3	6.1	15.0
21230	♂	231	76	30	41.0	24.9	19.3	6.4	14.0
21229	♂	234	80	31	39.1	24.8	19.7	6.5	14.4
21232	♂	218	75	28	36.3	21.4	18.6	5.8	11.1
21231	♀	219	77	28	38.3	22.9	18.9	6.2	12.8
2193	♀	230	80	30	39.6	22.6	18.7	6.5	12.7
2188	♀	220	71	30	38.6	22.5	18.4	6.5	13.2
2190	♀	210	65	29	38.6	23.3	18.4	6.6	12.5
1762	♀	209	69	29	38.0	21.7	17.7	6.4	13.3

(1) Measured over-all from anterior tips of nasals to most posterior points on occipital end of cranium, which are usually the condyles.

(2) Greatest breadth behind zygomatic arches; sometimes pertains to auditory tubes, sometimes the lateral protuberances of mastoids; often the parallel dividers touch both.

INDEX TO VOLUME IV, FOURTH SERIES.

New names in **heavy-faced type;** Synonyms in *italics.*

PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

VOL. V

1915

SAN FRANCISCO
PUBLISHED BY THE ACADEMY
1915

CONTENTS OF VOLUME V.

PLATES 1-19.

July 19, 1916

PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

VOL. V, Nos. 1 and 2, pp. 1—31 MARCH 26, 1915

I.

REPORT OF THE PRESIDENT OF THE ACADEMY FOR THE YEAR 1914

By C. E. GRUNSKY
President of the Academy

MEMBERSHIP

The present total membership in the Academy is 447, made up of:

Honorary Members	30
Life Members	83
Resident Members	334

During the year 1914 there was an accession of 10 new members, and the Academy lost by death 10, by resignation 37, and by being dropped for arrearages in dues, 11. The net loss in membership during the year has been 48.

The losses by death were:

W. C. Barnard	Resident	Member	June 5,	1914
Prof. Samuel B. Christy	Life	"	November 30,	"
F. W. Dohrmann	Resident	"	July 18,	"
Chas. Fuchs	"	"	June 11,	"
Dr. Theo. N. Gill	Honorary	"	September 25,	"
Prof. E. S. Holden	Life	"	March 16,	"
C. A. Hooper	Resident	"	July 12,	"
John H. W. Husing	"	"	January 31,	"
Thomas Magee	"	"	May 30,	"
J. G. Spaulding	"	"	March 29,	"

March 24, 1915

DONATIONS

The donations to the Museum during the year have been many and valuable, and presage what may be expected when adequate housing facilities are provided. A detailed list of the accessions to the Museum is given in the appendix to the Director's report. Attention may here be called to a few of the more notable donations and accessions.

SPECIAL ACCESSIONS TO THE MUSEUM AND ACADEMY'S EQUIPMENT

1. Through the generosity of Mr. Wm. M. Fitzhugh, of San Francisco, the Academy has received as a loan deposit the entire collection of Indian baskets, pottery, blankets, and miscellaneous objects, assembled by the late Professor and Mrs. T. S. C. Lowe of Pasadena, Cal. This collection comprises 1430 baskets and more than 300 pieces of pottery and other objects of Indian manufacture or use.

Mr. Fitzhugh has generously offered to meet all the expenses of installing these collections in the Museum in the most approved cases, and all expenses incident to the proper labelling and cataloguing of the specimens.

It is easy to see that this will make one of the most attractive exhibits in our new Museum building.

2. At the instance of Mr. Otto von Geldern, Mr. Thomas Davidson, son of the late Professor George Davidson, long an active member and sometime President of the Academy, has generously donated to the Academy a large collection, comprised in 24 large boxes, of minerals and other geological specimens.

3. Mr. Chas. E. Green, member of the Board of Trustees, donated to the Academy a Beck binocular microscope with eleven objectives (ranging from 4 inch to 1/25 inch), several eye pieces, and numerous accessories. The original cost of this microscope was over $1000. Although not a modern instrument it is nevertheless valuable.

4. Dr. Robert E. Coker, Director of the United States Bureau of Fisheries Biological Station at Fairport, Iowa, and acting for the Bureau, has donated to the Academy a collection of Unionidæ or freshwater mussels containing 423 speci-

mens, representing 116 species, or practically all the species occurring in North American waters.

5. Perhaps the most important gift which the Museum has received within the year is that of the Henry Hemphill collection of marine, freshwater and land shells, presented to the Academy by Mrs. Charlotte Hosmer, daughter of Mr. Hemphill.

This collection contains between 60,000 and 70,000 specimens representing 12,000 to 15,000 different species. Dr. Wm. H. Dall, the most distinguished conchologist in America, if not in the world, has pronounced it to be without doubt "the best and most complete collection of Pacific coast shells - - - - that is to be found anywhere except in the National Museum" at Washington.

The making of this immense collection engaged the attention of Mr. Hemphill during practically all the years of his long and useful life.

The collection has been formally turned over to the Academy and is now stored in 20 large boxes in the rear room on the third floor of the Security building, 343 Sansome street.

6. A collection of 34 mounted specimens representing 24 species of winter birds of Marin County, California, presented by Mr. John W. Mailliard, of the Board of Trustees. These are meant to serve as a beginning of a series of seasonal groups of birds which it is hoped will be installed in the Museum soon after the completion of the building.

7. A collection of 17 bird skins obtained by Mr. John Rowley in Kern County in October and November. Among these are two specimens of the ferruginous hawk, a very rare species.

8. Two fine specimens of the Javanese peacock, presented by Mr. Lansing K. Tevis, of San Francisco.

9. A collection of 56 mammal skins obtained by Mr. Rowley in October and November in Kern County, Cal.

10. During the year there have been added to the collections of the department of herpetology a total of 806 reptiles and amphibians. Of these, 105 resulted from exploration in Arizona and California by John I. Carlson, 248 by gift from various parties, and 453 by exchange.

11. The large collection of beetles belonging to the late Charles Fuchs, for many years the Academy's assistant curator of entomology, has been deposited with the Academy by Mrs. Fuchs, and an effort is being made to secure funds for its purchase.

The additions to the herbarium have been many and important, representing hundreds of specimens among which are many genera and species new to the herbarium. Among the most important additions may be mentioned the following:

12. A collection of 278 specimens representing 28 genera and 75 species of ferns chiefly from Massachusetts and the vicinity of Washington, D. C., donated by Mr. H. W. Henshaw of Washington, D. C.

13. A very large collection, especially rich in willows, made by Miss Eastwood in the Yukon region during the spring and summer of 1914.

14. Considerable collections of plants made by Miss Eastwood in March in Kern, Tulare and Contra Costa counties, California.

15. Large miscellaneous collections sent in from time to time by Mr. L. E. Smith, from the upper Sacramento Valley.

16. Numerous specimens, chiefly exotics, have been donated from time to time by Mr. G. P. Rixford.

17. Large collections of Japanese and Chinese plants have been received from Dr. Fred Baker and Mrs. Charlotte Baker, of San Diego, Cal.

18. A great many specimens adding many families, genera and species to the herbarium, have been received from the Director of the Philippine herbarium.

Miss Eastwood, the curator of botany, has been indefatigable in receiving and caring for the collections. In mounting the specimens, she has received great assistance from Mrs. Marian L. Campbell who has most generously given to the herbarium a day or more of her time nearly every week during the fall and winter.

Miss Eastwood conducts a botanical club of about 50 members which meets usually about once a week. She also meets once a week with the park gardeners and gives them instruction regarding the plants under their care. This is educational work of real value and should be encouraged.

ACCESSIONS TO THE LIBRARY

There have been the usual accessions to the library resulting from purchase, subscriptions to periodicals, and from exchanges. There have also been many donations as set forth in the appendix to the Director's report. Only a few of the more important donations will be mentioned here.

1. A collection of about 200 volumes and pamphlets from the late Professor William Eimbeck, received through Captain Ferdinand Westdahl of the United States Coast and Geodetic Survey.

2. Through the courtesy of Senator Geo. C. Perkins the library now receives regularly the Congressional Record, as issued.

3. The Director has presented to the library a bound set of the Proceedings of the Washington Academy of Sciences. This set comprises Volumes I-XIII, and is complete.

4. Mr. Horace Davis has presented to the library a complete original set of the publications of the Academy. The volumes are handsomely and substantially bound and constitute the most perfect set of the Academy's publications which it possesses.

5. A large number of pamphlets from the Gray Herbarium, among them many of the papers by Professor Asa Gray and Professor Sereno Watson.

6. Thirty-one numbers of the Journal of Morphology, from the Wistar Institute.

7. About 40 early numbers of the Proceedings of the California Academy of Sciences from Professor W. G. Farlow.

PUBLICATIONS

The Academy has published during 1914 five papers: One is No. X (Proc., 4th Ser., Vol. II, Part 1) of the series relating to the Expedition to the Galapagos Islands, and the other four are in continuation of Vol. IV, Fourth Series of the Proceedings, as follows:

The Gigantic Land Tortoises of the Galapagos Archipelago. By John Van Denburgh. Fourth Series, Vol. II, No. X, pp. 203-374, plates 12-124. Published September 30, 1914.

Report of the President of the Academy for the year 1913; and George Davidson. Fourth Series, Vol. IV, Nos. I and II, pp. 1-13. Published April 8, 1914.

Neocene Record in the Temblor Basin, California, and Neocene Deposits of the San Juan District, San Luis Obispo County. By Frank M. Anderson and Bruce Martin. Fourth Series, Vol. IV, No. 3, pp. 15-112, plates 1-10. Published December 30, 1914.

The Fauna of the Siphonalia sutterensis Zone in the Roseburg Quadrangle, Oregon. By Roy E. Dickerson. Fourth Series, Vol. IV, No. 4, pp. 113-128, plates 11 and 12. Published December 30, 1914.

Reptiles and Amphibians of the Islands of the West Coast of North America. By John Van Denburgh and Joseph R. Slevin. Fourth Series, Vol. IV, No. 5, pp. 127-152. Published December 30, 1914.

The Pocket Gopher of the Boreal Zone on San Jacinto Peak. By J. Grinnell and H. S. Swarth. Fourth Series, Vol. IV, No. 6, pp. 153-160. Published December 30, 1914.

The Academy also published on December 30, 1914, Title page and Contents, Vol. I, Mathematics-Physics, Third Series; Title page, Contents and Index, Vol. II, Geology, Third Series; Title page, Contents and Index, Vol. IV, Zoology, Third Series; Title page, Contents and Index, Vol. I, Fourth Series; and Title page, Contents and Index, Vol. III, Fourth Series. These complete in this respect all the volumes to date.

LECTURES

During the year 1914, 19 free lectures have been delivered at the stated meetings of the Academy, as follows:

FEBRUARY 2. "Poisonous reptiles of the Pacific Coast."
Dr. John Van Denburgh, Curator of Herpetology.

FEBRUARY 12. "Necessity for care in the determination of type specimens."
Bruce Martin, Asst. Curator of Invertebrate Paleontology.

MARCH 2. "Fertilization of the Smyrna Fig."
G. P. Rixford.

MARCH 16. "The last appearance of the Leonids."
C. E. Grunsky, President of the Academy.

April 6. "Specialization in the Protozoa and suggestions of Metazoan Origin."
Prof. C. A. Kofoid, University of California.

April 20. "Origin of petroleum."
F. M. Anderson, Curator of Invertebrate Paleontology.

May 4. "Geological history of California."
Dr. John Perrin Smith, Stanford University.

May 18. "Myths and songs of the Sierras."
Edward W. Gifford, University of California.

June 1. "Effect of a strictly vegetable diet on certain animals."
Dr. J. Rollin Slonaker, Assistant Professor of Physiology, Stanford University.

June 15. "The Alaska fur-seal herd and its proper management."
Dr. Barton W. Evermann, Director of the Museum.

July 6. "Status of California's duck population."
Dr. Harold C. Bryant, Assistant Curator of Birds, Museum of Vertebrate Zoology.

July 20. "Present conditions and future need of California's wild life."
Dr. Walter P. Taylor, Curator of Mammals, Museum of Vertebrate Zoology.

August 17. "Some experiences in Alaska".
Alice Eastwood, Curator of Botany.

September 21. "Life history of the edible crab."
Dr. Frank W. Weymouth, Assistant Professor of Physiology, Stanford University.

October 5. "Life of cells outside the body."
Dr. S. J. Holmes, Professor of Zoology, University of California.

November 16. "The census of the fur-seal herd."
Geo. A. Clark, Academic Secretary, Stanford University.

December 7. "Summer on the Forrester Island, Alaska, bird reservation."
Dr. Harold Heath, Professor of Zoology, Stanford University.

December 21. "Recent progress in determining the motion of bodies of the Solar System."
Dr. A. O. Leuschner, Professor of Astronomy, University of California.

THE DIRECTOR OF THE MUSEUM

The Academy has been fortunate in securing the services of Dr. Barton W. Evermann, who early in the year was appointed Director of the Museum to fill the vacancy caused by the resignation of Mr. G. P. Rixford. He came to us from

Washington, D. C., but not as a stranger, he having at one time been a resident of California and having in recent years had official duties on this coast by reason of his connection with the U. S. Bureau of Fisheries in various capacities since 1891, and in charge of the Alaska Fisheries Service since 1910. He has already rendered valuable service to the Academy and will have an enlarged field of usefulness when the Academy's new building in Golden Gate Park becomes available.

THE NEW MUSEUM BUILDING

A year ago it was confidently expected that this new building would be completed before the close of 1914. This has not been realized. It was found during the progress of construction that the principal contractors were not using the full amount of cement called for by their contract, that certain undesirable modifications of the specifications had been orally assented to by the agents of the Academy and that in consequence of these circumstances there was some doubt relating to the wisest procedure to remedy the resulting structural defects in the building. The complications resulting from this situation have interfered with the progress on the building. The matter is not yet finally adjusted but it is expected that a course of procedure will soon be determined on resulting in proper protection of the Academy's interests.[1]

GENERAL ACTIVITIES

The work done in the various departments under direction of the curators of these departments will be set forth in the reports of the Director of the Museum and of the curators, and needs no special comment in this report, except to state that the earnest and able work being done is gratifying and deserves the encouragement of this community, of the State, and of the entire Pacific slope. The field in which the Academy is active is large. The Academy is in need of funds for better covering this field and for extending its usefulness.

It is gratifying, therefore, to be able to give special acknowledgment to such donations as the valuable Henry Hemphill collection of shells and the loan of the Fitzhugh Collection of

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[1] Since the above was written all these matters have been adjusted, building operations have been resumed, and it is now believed the building will be completed early in July.

Indian baskets and stone implements, which latter will be placed in the new building and properly displayed without cost to the Academy.

But the time is ripe for a proper and adequate endowment for the work which the Academy has in hand. There is immediate need for a fund of about $1,000,000 to enlarge the new building in the Park to its intended ultimate dimensions and to provide for a proper display of the material which is available in abundance, and which will quickly find its way to such a building when it becomes known that attractive housing facilities have been provided.

A commission which the Curator of the Department of Botany, Miss Alice Eastwood, received, to make a study and collection of willows in Alaska, resulted in a trip by her last spring of which she has given an interesting account at one of the stated meetings. A large addition of Alaskan flora to the Herbarium of the Academy, is to be noted in this connection.

The Curator of the Department of Invertebrate Paleontology, Mr. F. M. Anderson, is at present away on a year's leave of absence in South America on private business and has taken with him Mr. Bruce Martin. His stay in South America will no doubt result in benefit to the Academy's collections as he has requested and is receiving some financial aid in making collections for the Academy.

The place made vacant by the resignation of the Assistant Curator, Mr. Bruce Martin, has been filled by the appointment of Dr. Roy E. Dickerson.

Death has claimed Mr. Chas. Fuchs who was for many years Assistant Curator and an able worker and diligent collector in the Department of Entomology. The private collection of Mr. Fuchs has been added to the Museum where it is being stored and cared for until otherwise disposed of. In his death the Academy has sustained a distinct loss. No one has yet been appointed to take his place.

The preparation of material for display exhibits has been continued throughout the year and it is along this line—measured by the cost of the work—that the Academy has been most active. This will appear more fully in the report of the Director.

In conclusion, on behalf of the officers of the Academy, I desire to express their gratification in the interest manifested by so many of the members and in the cordial effort put forth to advance the best interests of the Academy, which continues, as in the past, to devote itself to the education of our people along lines of natural history, science and related matters.

I desire to extend to the officers of the Academy thanks for their able and cordial cooperation in Academy affairs and for the many personal sacrifices which they have been called on to make on behalf of the Academy.

II

REPORT OF THE DIRECTOR OF THE MUSEUM FOR THE YEAR 1914

By Barton Warren Evermann
Director of the Museum

The appointment of the present Director of the Museum of the California Academy of Sciences became effective March 15, 1914. Before coming west he took the opportunity, with the permission of the Council, to visit a number of museums in the east, namely: the American Museum of Natural History in New York, the Museum of the Brooklyn Institute of Arts and Sciences, the Children's Museum in Brooklyn, the Field Museum of Natural History in Chicago, the Museum of the Chicago Academy of Sciences, and the Milwaukee Public Museum. Although already quite familiar with the United States National Museum at Washington, in which institution he had served as honorary curator of the Division of Fishes for a number of years, he devoted several days in the early part of March to a study of methods of caring for collections and installing exhibits, of the types of cases used in the different departments, the methods of museum bookkeeping, and many other matters relating to the administration of the affairs of that institution.

In all the institutions visited special atttention was given to the educational work which they are doing, and it is believed that much information and many suggestions were obtained which will prove of value to this Academy in the development and management of its Museum.

At the time of the director's arrival in San Francisco, construction work on the new Museum building of the Academy in Golden Gate Park was well under way, and it was confidently believed the building would be ready for occupancy certainly by the beginning of the year 1915. In anticipation of this probability, the Director at once began giving consideration to various matters pertaining to the transfer of the Academy's collections, library and offices, to the new building, and their proper installation therein. Consideration had to be given to many things, among which a few may be mentioned: The available space and its best allotment; provision

for proper lighting, heating and ventilation; provision for proper telephone service; type and arrangement of cases for exhibition groups and specimens, and for research collections; details of arrangement and equipment of lecture room and laboratories; type of book stacks and furniture for library and offices; and the details of many other matters of pressing importance preliminary to the installation of a museum in a new building and the making of provision for its expected growth. All of this required much time and thought.

Through the failure of the concrete and brick contractors to comply with the specifications in their contract, it became necessary to stop the construction work temporarily. This was done on July 13, and building operations have not yet[1] been resumed. It seemed best to defer further action in the selection of cases, book-stacks, and other furnishings until the present building embarrassment has been overcome.

Although those matters are at a temporary standstill, the Academy has not been idle. For details concerning the activities of the respective departments of the Museum reference is made to the formal reports of the curators. It is proper to call attention at this time to some of the special activities which have engaged the attention of the Museum force.

SPECIAL ACTIVITIES

1. Early in the spring a proposition was received from Messrs. Miller and Lux to turn over to the Academy, free on board the cars at Buttonwillow, Kern County, Cal., such of the California Valley elk as they might be able to catch from the herd which roams over their Kern County ranch, if the Academy would place them in suitable large Federal, State, and private reservations and parks in the state.

Realizing that under existing conditions this important species of big game is seriously threatened with extermination, and being desirous of assisting in preserving the species, the Academy accepted the offer. Considerable time and attention were given to the matter during the summer and fall. Communications were addressed to the superintendents in control of the Federal and State reservations, and to owners of large

[1] January 4, 1915. Since the above was written the building difficulties have been adjusted, construction work has been resumed, and it is now (March 18) believed the building will be ready for occupancy early in July.

private reservations, parks, and ranches in the state, also to the park commissioners and the Lodges of Elks in all the cities of the state, for the purpose of learning whether they wished any of the elk for the reservations or parks under their control.

It was explained to them that these elk were in great danger of extermination; that Messrs. Miller and Lux were desirous of doing anything in their power to save the species; that the Academy of Sciences is cooperating with Miller and Lux with that object in view; that it is desired to place the elk only in such places as will afford a favorable environment in which the animals will breed and thrive; and that the only expense to those wishing any of the elk would be the freight charges and other expenses incident to shipment, and $3 dollars per head to meet the expense of clerical work.

The response was immediate. Approval of the proposition was universal. Applications for elk were received from many parts of the state. In order that the elk might be placed only in favorable locations the Director through the courtesy of the Southern Pacific and Santa Fe railroads, was able to visit and personally inspect more than twenty of the proposed reservations and parks, and only those thought to furnish a suitable environment were selected to receive shipments.

Early in October, Messrs. Miller and Lux began preparations for capturing the elk. The plan involved the construction of a corral a quarter of a mile long and half as wide in a large alfalfa field to which it was observed the elk came regularly every night to feed. The corral was built of heavy timbers 12 feet high upon which was placed heavy woven fence-wire nine feet high. A wing one-fourth mile long was run out from each side at the corral entrance. The wire was placed on the wings at once but not on the corral proper until the elk had visited the field several nights and had become quite used to the posts, which they did very promptly. Then the wire was put in place everywhere except at the entrance, and on the night following, after about 150 elk had entered the corral, the wire was put in place across the entrance and the elk were trapped. The next day they were quite restless and about 90 of them broke out. About 60 remained and in a few days became so tame that it was safe to undertake their

capture and transfer to the cattle pens at the railroad station a Buttonwillow.

The actual catching, however, was attended with many difficulties and uncertainties. Two escaped by clearing an eight and one-half foot fence. They came nearer flying than was believed possible for such animals.

In spite of all difficulties, 54 elk were successfully shipped to the following:

	No.
One thousand acre reservation in the Santa Monica Mountains, owned by Mr. J. M. Danziger of Los Angeles	6
Six hundred and forty acre reservation in the Santa Monica Mountains, owned by Mr. E. L. Doheny of Los Angeles	10
San Diego City Park	12
Private reservation of several hundred acres adjoining the city park at Riverside, and owned by Mr. S. C. Evans of that city	4
Modesto City Park	2
California Redwood Park Association, Boulder Creek	10
Del Monte Park, Seventeen-mile Drive, Monterey	10

Not a single loss occurred during shipment.

Reports recently received from these various places state that the elk promptly adapted themselves to the new environment and that they are doing well. It is confidently believed that these elk will reproduce in practically all of these reservations and that ever-increasing herds will result.

The Academy has unfilled orders for about 100 additional head. It is the intention of Messrs. Miller & Lux to undertake the capture of more elk next fall, and it is hoped that all unfilled orders may be supplied.

The degree of success that will be attained can not, however, be predicted; the uncertainties are many and various. In the first place, Miller & Lux may fail in their attempt to capture the animals. And then, even after having been captured, they may break out of the corral; they may escape when being transferred from the corral to the cattle pens; they may break out of the cattle pens; or kill themselves by fighting with each other; or escape when being loaded into the cars; or injure

each other in the cars while in transit; or escape or suffer injury when being unloaded.

The experience of the last season will prove very profitable, however, and it is believed that the undertaking next season will be attended with even a greater measure of success.

2. During the spring and summer, the curator of botany, Miss Eastwood, spent several months on a collecting trip in Alaska and the Yukon Territory, and brought back large and very valuable collections of plants, particularly of willows. The details are set forth in Miss Eastwood's formal report.

3. The curators and assistant curators have been diligent in arranging, cataloguing, caring for, and studying the collections in their respective departments. The inadequate quarters which the Academy now occupies make it impossible to properly arrange the collections, and any study of them is almost impossible.

4. The department of mammalogy has made commendable progress with the preparation of the exhibition groups which are to be installed in the new museum building.

The main exhibition hall of the new building is to be devoted to the large California mammals and the more interesting of the smaller species. This hall will accommodate 10 large habitat groups each 25 feet long, and with a 15-foot plate glass front. There will also be room for 20 smaller habitat groups of the smaller California mammals. The rear exhibition hall will have space for six large habitat groups and 12 small groups of the same size and general character as those in the main hall.

The curator of mammals reports that his taxidermists and preparators now have completed and ready to instal in the new building the following large mammal groups: Black-tail Deer, four seasonal groups,—spring, summer, autumn and winter; California Mule Deer; California Valley Elk; Desert Mountain Sheep; California Antelope; Black Bear; California Mountain Lion; California Sea Lion; Steller's Sea Lion; Leopard Seal; Galapagos Gigantic Tortoise; Farallon bird group; Los Baños bird group; and California coast bird group. These and others in preparation will more than fill the proposed available space.

These groups should be installed as rapidly as possible after the completion of the building. It is believed they will prove a great attraction and indicate to the public that the museum is an educational institution.

CARE OF COLLECTIONS

All the collections of the Academy have been regularly and carefully inspected with reference to possible danger from insect pests or other causes.

The mammal, bird, and insect collections were inspected in the summer and again in the fall, and found in satisfactory condition. The materials for the large bird groups were examined in December and found to be in excellent condition. These materials have been transferred from Berkeley to a basement room in the Security Building at 343 Sansome Street. The room is a better one than that in which the collections were previously stored and costs nothing for rent.

MUSEUM PERSONNEL

Some changes have taken place in the personnel of the Museum.

Mr. Frank M. Anderson, curator of the department of invertebrate paleontology was granted leave of absence May 1, 1914, to permit him to engage in certain economic work in South America in the interest of an oil company.

Mr. Bruce Martin, assistant curator of the department of invertebrate paleontology, resigned on May 1 to accompany Mr. Anderson to South America, and Dr. Roy E. Dickerson was appointed to the vacancy caused by Mr. Martin's resignation, effective August first.

Mr. Chas. Fuchs, for many years the assistant curator of entomology, died June 11, 1914. Mr. Fuchs had served the Academy long and faithfully. His skill as a preparator of entomological specimens was unsurpassed. His enthusiasm and his pleasant, unaffected disposition endeared him to all with whom he was associated. In his death the Academy suffers a real loss.

ACCESSIONS TO THE MUSEUM

Although the Academy conducted no extensive field investigations during the year, the additions to the Museum have nevertheless been many and important. Most of these have been in the nature of donations by friends of the Academy. A detailed list will be found in an appendix to this report. Attention is called in the President's report to a few of the more important accessions.

THE MUSEUM

As already stated, because of the failure of the concrete and brick contractors to comply with their contract, the completion of the new Museum building has been delayed several months. It is believed, however, that the difficulties will soon be adjusted, that construction work will be resumed within a short time, and that the building will be ready for occupancy in the near future.

In the meantime, it is proper to consider some of the problems which will confront us when we are actually in the new building.

With the completion of the new Museum building, the Academy will enter upon a new era. It will then have an opportunity to develop its Museum along what it regards as the most proper lines. The first important question that must be considered is that of policy. What shall be the scope of the Museum's work? What shall be its ideals and its aims? How can its ideals and aims be realized?

These questions are so vital that I feel that I should take this opportunity to touch briefly upon them.

Chiefly through the efforts of Mr. Loomis, assisted by President Grunsky and Judge Hittell, the property of the California Academy of Sciences was exempted from taxation by a constitutional amendment. That action by the people of the State placed an obligation on the Academy, an obligation to every person in the state. The Academy must do something for the people of San Francisco and the state in return for what the state has done for it.

When the Academy gets into the new building it will then be in a position to do many things; there will be many things

it will wish to do; there will be many things it must do; there will be many problems it must then meet. The time is opportune for consideration of some of those problems.

The first question to consider is the large and fundamental one as to the general policy of the Museum.

The character or type of museum which the Academy wishes to maintain must be determined. Along what lines shall its principal activities lie? How can it do the most good as a scientific, educational institution?

The one thing that will impress one most in a study of eastern museums is their activity along educational lines, and the ways in which they are endeavoring to interest the public, and to be of service to the public.

It is apparent that the museums of the east are beginning to realize more and more that they owe a debt to the public and to those who have made their existence possible. Until recently most museums have done little or nothing in respect to general education. "They have been content to be merely vast depositories for collections of priceless value, either unseen or gazed upon in mute wonder by those who visited them."

In such museums the visitors "wander listlessly and aimlessly about the halls and galleries, with little appreciation and scarcely any understanding of the treasures that surround them."

But a great change has come about within the last few years. Now, the museum has come to regard itself, and to be regarded by the public, as an educational institution, working in cooperation with the public and private schools for the good of all the children who can be brought under its influence. It is now realized that a public museum, in order to justify its existence, must be of real service, not only to investigators, but to the general public, as well.

To meet the needs of the investigator, the museum must be an institution for research, an institution for the acquirement of knowledge and its diffusion among men. A museum furnishes facilities for research and the acquirement of knowledge through, and in proportion to the completeness of, its research collections, and the encouragement it gives to field and laboratory investigations. The knowledge acquired by

its investigators through field investigations and laboratory study of specimens is made known to the world chiefly through the medium of the museum's publications.

This important function of the museum has been admirably performed by the California Academy of Sciences. Its publications have always been of a high order of excellence, and through them the Academy is well and favorably known throughout the scientific world. This function of the museum must not be neglected; research must be encouraged in every proper way.

The second function of a public museum is that of usefulness to the public in an educational way. Not until recently has this function been realized or received much atttention, but now it is the dominant and controlling thought in many of our greatest museums.

It is true that most museums, from the very beginning, have maintained considerable collections of natural history objects, and specimens in other groups, which the visitor might see; but, as Director Lucas of the American Museum of Natural History has so well said, "The visitor was greeted by row upon row of animals, most literally stuffed, arrayed in ranks and accompanied by labels whose principal mission was to convey to the public what to them is a most unimportant matter, the scientific names."

Shall our Museum be a "Haunt of the Muses", such as Ptolemy Soter founded at Alexandria in 300 B. C.? Yes, it should be that, but it must be much more than that. It should be not only a place "dedicated to the cultivation of learning" and frequented by men and women devoted to learning and the improvement of human knowledge, but it should also be a treasure-house of specimens of the animals, plants and other natural objects of the world, and of objects illustrative of the life and activities of the races of men.

Museums, in the modern sense of the word, had their origin in the effort to preserve and care for rare and curious objects which travelers brought home from distant parts of the world. Collecting of rare and strange objects was first raised to the dignity of a fine art in Italy. The Medici at Florence and the Estes in Modena were the first; they set the example which in time spread throughout Europe.

But the collectors of those days were rarely imbued with the scientific, or even educational spirit; their motives were largely selfish, or would be so regarded in our day. They were usually wealthy and cultivated amateurs who assembled and maintained collections for their own pleasure and glorification. It was not until 1753—just 100 years before the founding of the California Academy of Sciences—when the British Museum was established at Bloomsbury and the collections of Sir Hans Sloane acquired, that the idea of a public museum emerged. It was then realized, apparently for the first time, that a museum, to advance art and scientific knowledge, must be liberally endowed, or else fostered by the State. And it was not long ago that museums first began to realize that they have a double duty to perform.

The Museum of this Academy, speaking broadly, has two primary functions. In the first place, it must furnish materials and facilities for research, and men to carry on the research work. While its legitimate field is not limited by geographic boundaries or to particular subjects in the realm of science, it is particularly appropriate that it should concern itself with problems concerning the natural history, geology, and anthropology of the Pacific coast of the Americas and of the Pacific islands. The problems within these fields are many and tremendously important. Their study will result in many valuable contributions to human knowledge. The collections which would be made in connection with these investigations will add greatly to the Museum's treasures. Those that would be obtained from the islands of the Pacific would make it possible to build up here in San Francisco a great Polynesian Museum. San Francisco is the logical place for such a museum. It should be the ambition of the California Academy of Sciences and the people of California to build up such a museum. Such an undertaking should receive substantial encouragement.

And the research collections of the animals and plants, of the geology, paleontology, and the native races of western America and of the Pacific Ocean and its islands, should be comprehensive and ample for the investigator's use.

Then there is the educational obligation which the Academy owes to the public and the state. This obligation can be met

in a number of ways, a few of which may be briefly mentioned here. In the first place, the Academy must instal and maintain in its Museum objects and groups of objects that are educative in character; that will teach definite lessons; and they must be displayed in such manner as will enable the visitor readily to gain the knowledge which the exhibit is meant to impart. And right there is a vital point: the object must be displayed in a way which will enable the visitor to understand the lesson it is meant to teach. To be sure, the collections must be properly labelled and placed in good light, but that is not enough. The arrangement and the grouping must be considered. And there must be intelligent, sympathetic interpreters or guides whose appreciation of the lessons to be taught, and whose enthusiasm will become contagious as the exhibits are explained to the visitors. The visitors will thus get the most out of what they see. Among exhibits that can be made of the greatest popular interest and highest educational value are the large habitat groups of California animals to which reference has already been made. Added to these there should be seasonal groups of birds and other animals, in which the animals will be shown in natural surroundings as they appear at different seasons of the year. For example, there should be four seasonal groups of the birds of the vicinity of San Francisco, one showing the winter species under winter conditions, and one for each of the other seasons. Similar groups of ptarmigan, snowshoe rabbits, deer and other animals will be provided.

Then there is the Lowe collection of Indian baskets, pottery and other objects of Indian manufacture and use now ready to instal, a collection that has great educational value.

And still another now available is the Henry Hemphill conchological collection of marine, freshwater and land shells, especially rich in west coast species, and very valuable not only for exhibition purposes but also for research.

Then, in addition to the large habitat and ecological groups, the museum must contain small groups or family groups of small animals of special interest and educational value. These groups should be many in number because the lessons are many and important which can best be taught by them. And a well-appointed museum will make it possible for every child in

the city, or any child who can come to the museum, to see and study and understand these specimens.

It seems to me that the educational function of our museum is the thing we now should emphasize and make provision for. It has been too long neglected. There are various ways, in addition to the one already dwelt upon, through which this purpose of the museum can be realized. I may be permitted to mention a few of them:

A carefully thought-out method of cooperation with the public and private schools must be provided. In the preparation of exhibition material provision should be made for exhibits that will meet the needs of children of each of the school grades. There should be exhibits that even first and second grade children, as well as those of the higher grades, can understand, and which will teach them definite lessons. And there should be exhibits adapted to each of the eight grades and to the high school.

There should be maintained at the museum throughout the school year courses of lectures on natural history and related subjects, such as should form a part of the regular school curriculum. These lectures should be given daily. They would be adapted to the needs of the various grades. They should relate to subjects for which the museum possesses in its collections illustrative materials. The museum should also provide carefully selected stereopticon slides, moving pictures, transparencies, photographs, and other educational aids for use in its educational work.

The museum should begin as soon as possible to provide loan collections to send out to the schools. These should be small habitat groups and specimens of the smaller birds, mammals, reptiles, batrachians, fishes, insects, minerals, plants, and other natural objects which can be put up in portable cases of a form and size convenient for handling. It is believed this will prove to be one of the most effective methods of cooperation with the public schools.

Another way in which the museum can be of benefit to the schools is by encouraging the teachers in the schools to visit the museum and make use of its materials, and by encouraging its curators and others connected with the museum to give lectures before schools, teachers, and educational organizations

on subjects in which they are specialists. These lectures may be given either in the schools or at the museum, or wherever circumstances may require.

The museum must be a *public* museum. We have long had public schools designed to prepare our children for rational living and good citizenship. A little later public libraries came to be considered as a necessary part of the educational plant. If *public schools* and *public libraries, why not public museums?*

Every city, town and community in the land taxes itself heavily to support the public schools. Many do the same for public libraries. A few, a very few as yet, tax themselves to support public museums. But the time is not far distant, I verily believe, when the public museum will be recognized as an essential part of the educational equipment of every town and city.

Now, all this means money and men. A great museum can not be built up nor maintained without funds and men.

Provision must be made for the expenses of field work, of exploration and research. And the museum must have adequate funds and an adequate force of experts to prepare the habitat groups and the other exhibition material, the loan collections, the transparencies, the photographs and stereopticon slides; to care for the research and other collections; to do the research work; and to do the multitude of things which must be done in any live, growing, efficient museum.

Undoubtedly the best way to build up and maintain a great museum is by means of large general and specific endowments which yield definite annual incomes to be devoted to specific purposes. Among the endowments which the California Academy of Sciences should receive the following may be mentioned:

1. *An Endowment for Exploration and Research.*

This endowment should be in a sum of not less than $2,500,000 that would yield an income of, say, $100,000, to be devoted to exploration and investigation of the zoology, botany, geology, and anthropology of the Pacific coasts of the Americas and the islands of the Pacific. The need for this endowment is urgent, for the native races of these regions

and their works are passing, and the studies must be undertaken before it is too late.

A great Polynesian museum should be built up here in San Francisco. This is the logical place for such a museum. It should contain great research collections of the animals and plants and minerals of all the countries bordering on the Pacific, but there should also be well selected exhibits showing the natural and manufactured products of all these countries, displayed after the manner followed in the great commercial museums of the world. Such exhibits would serve to call the attention of men of business to the commercial products and possibilities of the various countries concerned, and would do much toward bringing the trade of those countries to San Francisco. The possibilities along this line can scarcely be overestimated.

2. *An Educational Extension Endowment.*

This endowment should be $250,000 and yield an annual income of about $10,000, to be used in the preparation of loan exhibits and collections to send out to the public and private schools; in the maintenance of courses of lectures at the museum and in the schools, on subjects adapted to the needs and understanding of the children of the different grades; in the preparation of stereopticon slides, photographs, transparencies, and moving pictures, relating to the various branches of elementary science which properly form parts of a well-balanced school curriculum; in short, to provide for cooperation between the museum and the public schools.

It is believed this is one of the most useful activities in which the museum can engage.

Recently Mr. N. W. Harris of Chicago gave to the Field Museum of Natural History a quarter of a million dollars as an endowment for this purpose. It is known as "The N. W. Harris Public School Extension of Field Museum of Natural History." It yields an annual income of $12,000, all of which is devoted to cooperation with the public schools of Chicago. Cannot a similar fund be secured for similar work in California? Is there not some one who is interested in education who is able and willing to do as much for San Francisco?

3. *A Library Endowment.*

A great library of the natural and physical sciences should be built up here in San Francisco. A large endowment is necessary; but for the present, if an endowment of not less than $200,000 can be secured the immediate needs would be fairly well met. The income from this fund, amounting to $8,000 to $10,000 would be used in the purchase of books, pamphlets and periodicals, for binding, and other expenses incident to building up and maintaining the library.

4. *Publication Fund.*

The publication fund of the Academy has never been adequate. It is very inadequate now. Papers of the highest scientific value have to be refused every year because of lack of funds for their publication. Because of the lack of funds the Academy has never been able to use the durable paper for the text and for the illustrations which the high value of its publications demands. Papers of the greatest value have been printed on paper that will probably not last fifty years. An endowment of $100,000 would be of very great help in enabling the Academy to print its publications in proper form and to maintain its Proceedings at a high standard of excellence.

In addition to these large and urgently important needs of the Academy, there are many smaller special needs. Each of the departments in the Academy has, and will always have, need for funds for special investigations. There are, for example, special problems which the department of geology is interested in and which it would like to undertake to solve. And the same is equally true of the other departments, particularly of botany, herpetology, invertebrate paleontology, invertebrate zoology, ornithology, entomology, and mammalogy. There should be small endowments for each of these departments in order that each may be assured of a reasonable sum for field work every year.

President Grunsky has called attention to the Academy's immediate need of not less than a million dollars for completing the museum building in all its units as originally designed and as urgently needed. The west wing now nearing completion will be inadequate to house the collections that the Academy

already possesses, to say nothing of the space needed for the expected immediate rapid growth of the museum.

I have said nothing about the need of a great aquarium in this city in which may be shown the food and game fishes and the myriads of other fishes and other life of our rivers and lakes and of the sea. Such an aquarium is sure to come. Now is the opportune time seriously to consider its establishment. The Academy of Sciences stands ready to render any service it can in this matter.

I have mentioned a few of the things which the California Academy of Sciences ought to do and which it can do if it receives the support from the public which it should receive. There are many other scientific and educational activities in which it will doubtless engage in due time.

The total of the endowments and gifts needed by the Academy is big. But the problems are big, and the educational, scientific, and material benefits that will come to San Francisco and the entire Pacific coast will be of inestimable value.

Recently I compiled a statement showing the amounts given by public spirited citizens of the United States for educational and scientific aid and endowments as noted in the weekly journal, *Science,* for the period from March to December, 1914. The total is nearly $77,000,000. Practically all of this enormous amount was given by men and women in the east and to museums and other educational institutions east of the Rocky Mountains.

No one believes that the men and women of wealth of the west coast of America are less appreciative of science and the educational value of the physical and biological sciences than are the people of the east. It is believed, that, when the matter is presented to them frankly and clearly, they will come forward and enable the Museum of the California Academy of Sciences to take rank with the greatest museums of the east.

There is one other matter to which I wish to call particular attention at this time. It is this: The new Museum should contain a Children's Room in which will be displayed natural history objects such as are particularly attractive and interesting to young children. There would be in this room brightly and curiously colored birds and butterflies, moths and beetles

and other insects; curious animals of other groups; attractive minerals, growing plants, and aquariums with interesting animal and plant life; colored transparencies of beautiful native flowers, all selected and arranged with reference to the telling of an interesting story, of teaching a definite lesson.

And there will be in this Children's Room a Children's Reading Room in which will be found a library of the interesting and reliable nature books and helps to nature study.

And there will be in charge of this Children's Room a well-educated, kindly, sympathetic woman, who knows animals and plants; who knows the specimens in the museum and the live things in the park about it; and who, above all, knows and loves children; a woman who can wisely direct the observation and the reading of the children so that they may correlate their reading with what they have seen in the museum or in the open, and thus *increase* rather than *stifle* their love of animate things, as our public schools almost invariably do. It will be arranged so that children of the different grades will come to this room at different hours, and receive the instruction and help adapted to their respective needs.

And all this will be done and done soon, I confidently believe. It will be done because it so evidently appeals to us all as being the *right thing to do,* the right sort of education and training to give our children. It will be done, because the beauty of it all, for the little children's sake, will appeal to someone who has prospered in this world; someone with a kindly heart, who loves children, and who wants to help them to become the men and women they should become; and some day that man will come forward and, out of his abundance, he will make it possible for the California Academy of Sciences to do this splendid work for the children of California, not only of today but for those of the years to come.

APPENDIX TO DIRECTOR'S REPORT

LIST OF ACCESSIONS TO THE MUSEUM, 1914

Arnold Arboretum, Jamaica Plain, Mass.: A collection of 188 sheets of herbarium specimens, chiefly cultivated shrubs.

Baker, Dr. Fred and Dr. Charlotte, San Diego, Cal.: Twelve hundred specimens from Japan all carefully identified by local botanists and labelled.

Basel Museum, Basel, Switzerland: Three reptiles and batrachians from Canary Islands, 3 from Ceylon, one reptile from New Hebrides Islands, and one each from China and Algeria, 2 from Loyalty Islands and 4 from New Caledonia. Exchange.

Beck, Mrs. R. H., Berryessa, Cal.: A small collection of insects from the west coast of South America. Purchase.

Bekeart, Phil B., San Francisco: Medallion portrait of Col. Samuel Colt.

Bliss, W. D., Truckee, Cal.: One flying squirrel.

Bolton, Arthur L., California Academy of Sciences: Several specimens of plants from southeastern Arizona, among them two species that appear to be new.

Brimley, C. S., Raleigh, N. C.: Sixteen batrachians from North Carolina, one from Alabama, two from the Bahamas, 7 reptiles and batrachians from Florida, 9 from Mexico and 10 from Panama, and 6 reptiles from Michigan. Exchange.

British Museum, London: One reptile each from Senagambia, Gold Coast of Africa, and South America. Exchange.

Brizini, Lieut., Manila, P. I.: One reptile from Philippine Islands.

Carlson, John I., California Academy of Sciences: A small collection of insects from southern California.

Carlson, John I., California Academy of Sciences: Sixty-nine specimens of reptiles and batrachians from Arizona and 36 from California.

Carlson, John I., California Academy of Sciences: A collection of 94 sheets of herbarium specimens from Tucson and Agua Caliente, Arizona, and from Santa Catalina Island, California.

Coker, Dr. Robert E., U. S. Biological Station, Fairport, Iowa: A collection of 423 shells representing 116 species of freshwater mussels *(Unionidæ)*, chiefly from the Mississippi Valley.

Coombes, Mrs. A. L., San Francisco: Twenty-four specimens of plants from southern Oregon.

Davidson, Thomas, San Francisco: A large collection of minerals formerly belonging to the late Professor George Davidson.

Dickerson, Dr. Roy E., California Academy of Sciences: A collection of about 40 species of fossils from the Eocene of Marysville Buttes.

Dudley Herbarium, Stanford University, Cal.: A collection of 178 sheets of plants, chiefly Californian.

Duncan, Carl B., Fresno, Cal.: Eight reptiles and batrachians from Fresno, Cal.

Duncan, Carl B., Fresno, Cal.: One bat.

Eastwood, Miss Alice, California Academy of Sciences: About 400 specimens of plants representing 96 additions to the herbarium with many duplicates, from Byron Springs and Antioch, Cal.; 500 plants with 110 additions, from the lower San Joaquin Valley; 112 from Mt. Rainier; 23 from Steilacoom, Wash.; 9 from Portland, Ore.; about 8000 specimens representing 1013 additions resulting from the Eastwood Yukon-Alaska expedition financed by Professor C. S. Sargent, head of the Arnold Arboretum; and many specimens of exotic plants from the region around San Francisco.

Edmands, W. O., Upper Lake, Cal.: Skull of a Kodiak bear.

Ehrhorn, Adolph, San Francisco: A rawhide trunk from Peru, S. A.

Evermann, Dr. Barton W., California Academy of Sciences: Nine reptiles and batrachians from Ventura and Kern counties, Cal.

Evermann, Dr. Barton W., California Academy of Sciences: Skull of a chipmunk, *Eutamias merriami,* taken from a rattlesnake *(Crotalus oregonus)* in the Yosemite Valley.

Evermann, Dr. Barton W., California Academy of Sciences: Thirty sheets of herbarium specimens from Ventura and Kern counties, California.

Evermann, Dr. Barton W., California Academy of Sciences: A collection of Lower Miocene fossils from Ventura County, Cal.

Fitzhugh, Hon. Wm. M., San Francisco: The Lowe collection of Indian baskets, pottery, blankets, and miscellaneous objects of Indian manufacture and use. An indefinite loan.

Fuchs, Charles, California Academy of Sciences: Seven reptiles and batrachians, from Alameda and Napa counties, Cal.

Gifford, E. W., Affiliated Colleges, San Francisco: One snake from Santa Clara County, Cal.

Green, Chas. E., San Francisco: A Beck microscope, with numerous objectives and accessories.

Greene, Dr. Edward L., Washington, D. C.: Fifty specimens of western plants, including some duplicates of his types.

Henry, Professor J. K., Vancouver, B. C.: A collection of fifty plants from the vicinity of Vancouver.

Henshaw, H. W., Biological Survey, Washington, D. C.: A collection of 278 specimens representing 28 genera and 75 species of ferns chiefly from Massachusetts and the vicinity of Washington, D. C.

Hosmer, Mrs. Charlotte, Oakland, Cal.: The Henry Hemphill collection of marine, freshwater and land shells, embracing more than 60,000 specimens representing more than 12,000 species.

Kellers, Dr. H. D., U. S. Navy: A collection of 56 sheets of herbarium specimens from St. Paul Island, Bering Sea.

Kusche, J. Aug., Eldridge, Cal.: Twenty-three specimens of reptiles and batrachians, from Los Angeles County, Cal.

Lockwood, A. D., San Francisco: Suit of Chinese armor.

Mailliard, John W., San Francisco: A collection of 34 mounted specimens representing 24 species of winter birds of Marin County, Cal.

Mailliard, Joseph, San Francisco: A ball of crude rubber from Peru, S. A.

Martin, Bruce, Lorica, Colombia, S. A.: A small collection of insects, mostly beetles, from Colombia, S. A.

Martin, Bruce, Lorica, Colombia, S. A.: Several hundred specimens representing about 200 species of fossils from the Tejon of California.

Merrill, E. D., Philippine Bureau of Science, Manila, P. I.: Three hundred specimens of Philippine plants.

Michigan, University of, Ann Arbor, Mich.: Eight reptiles from Michigan and two batrachians from Illinois. Exchange.

Museum of Comparative Zoology, Cambridge, Mass.: Thirty-one reptiles and batrachians from West Africa, 4 from Ecuador, 150 from the West Indies, 3 batrachians from East Africa, 22 from Florida, 10 from Massachusetts, 36 from Chile, 2 reptiles from North Africa, one from Ceylon, 4 from Brazil, and 5 from Panama. Exchange.

National Herbarium, Washington, D. C.: Seventy specimens of plants from the Mississippi Valley, a duplicate set of the Eggert collection.

Newell, Mrs. Gwendolan, San Francisco: A collection of 150 sheets of herbarium specimens from Los Gatos, Santa Barbara, and Fort Bragg, Cal.

Percy, Earl N., Standard Oil Co., San Francisco: Two hundred feet of moving picture film showing California Valley elk.

Phelps, Mrs. Kate Eastwood, Denver, Colo.: A collection of 90 sheets of herbarium specimens from Silver Lake, near Boulder, Colorado.

Ray, Milton S., San Francisco: One reptile from Napa Co., Cal.

Rixford, G. P., San Francisco: Thirty-five specimens of plants, chiefly rare exotics cultivated in California.

Rothschild, Hon. Walter, Tring, England: One tortoise shell from Madagascar, and seven casts of Galapagos and Madagascar gigantic tortoises. Exchange.

Rowley, John, California Academy of Sciences: A collection of 76 mammal skins chiefly from Kern County, Cal.

Rowley, John, California Academy of Sciences: Seventeen skins of birds from Kern County, Cal.

Sargeant, Jr. W. W., San Francisco: Two reptiles from San Francisco, Cal.

Slevin, J. R., California Academy of Sciences: Five batrachians from Washington, and 138 reptiles and batrachians from Kern and San Francisco counties, Cal.

Slevin, J. R., California Academy of Sciences: A small series of insects from Washington.

Smith, L. E., Sisson, Cal.: Eight hundred specimens of plants representing 186 additions to the herbarium, the rest being duplicates to be used in exchange. These were collected in northern California and chiefly in the upper Sacramento valley.

Tevis, Lansing K., San Francisco: Two specimens of a Javanese peacock.

Tracy, Mrs. William, Buttonwillow, Cal.: Two ostrich eggs.

Van Denburgh, Dr. John, California Academy of Sciences: One reptile from Santa Clara County, Cal.

Van Dyke, Dr. Edwin C., California Academy of Sciences: Forty-six batrachians from Washington; 4 reptiles and batrachians from Oregon.

Van Dyke, Dr. Edwin C., California Academy of Sciences: A considerable collection of miscellaneous insects from Washington, Oregon and California.

Wilkens, Mrs. J. E., San Francisco: Two reptiles from San Francisco.

LIST OF DONATIONS TO THE LIBRARY, 1914

Baker, Dr. Fred, San Diego, Cal.: Eight pamphlets.

Berry, S. Stillman, Redlands, Cal.: Twenty-two pamphlets.

Cobb, W. Bruce: One volume.

Crocker, Wm. H., San Francisco: Two volumes, Birds of New York.

Eimbeck, Wm., through Capt. Ferdinand Westdahl, San Francisco: A miscellaneous collection of more than 200 books and pamphlets.

Evermann, Dr. Barton W., San Francisco: A complete bound set (13 volumes) Proceedings of the Washington Academy of Sciences, and a copy of American Food and Game Fishes.

Farlow, Prof. W. G., Cambridge, Mass.: About 40 early numbers of the Proceedings of the California Academy of Sciences.

Gray Herbarium, Harvard University: One hundred and eighty pamphlets including many papers by Professor Asa Gray and Professor Sereno Watson.

Green, C. E., San Francisco: Four portraits.

Holmes, Prof. S. J., Berkeley, Cal.: Three pamphlets.

Jones, R. L.: Life of J. Clancy Jones, 2 volumes.

Kahn, Hon. Julius, San Francisco: The Laws of Alaska.

Loomis, Leverett Mills, San Francisco: One book and 53 pamphlets.

Mailliard, Joseph, San Francisco: The Native British Ferns, and 30 pamphlets.

Manson, Dr. Marsden, Bellota, Cal.: One pamphlet.

Martin, Bruce, Lorica, Colombia, S. A.: One volume.

Meinecke, Dr. E. P., San Francisco: One pamphlet.

Mexico, National Museum of: Two volumes.

Mills College, Margaret Carnegie Library of, Mills College, Cal.: One volume.

National Museum, Washington, D. C.: Five pamphlets, Contributions to the National Herbarium.

Royal Botanical Gardens, Kew, England: Nine bulletins.

Schaller, Dr. W. T., U. S. Geological Survey, Washington, D. C.: Two mineralogical papers.

Smith, Prof. J. Perrin, Stanford University, Cal.: Four pamphlets.

Thompson, Dr. J. C., U. S. Navy: Three pamphlets.

Torrey Botanical Club, New York City: Twelve copies of Torreya.

Van Denburgh, Dr. John, San Francisco: Two pamphlets.

Wilson, Guy W., New Brunswick, N. J.: Seven pamphlets.

Wistar Institute: Thirty-one numbers of the Journal of Morphology.

Zoological Society of New York, New York City: Seven pamphlets.

PROCEEDINGS

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FAUNA OF THE TYPE TEJON: ITS RELATION TO THE COWLITZ PHASE OF THE TEJON GROUP OF WASHINGTON

BY

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June 15, 1915.

Gastropoda

INTRODUCTION.

The Tejon group of California has a very characteristic fauna and, partially on this account, strata of this group have been recognized easily in many places throughout this state and in the neighboring states of Oregon and Washington.

An examination of the fauna of the type locality of the Tejon on Cañada de las Uvas has revealed many new species and many species described from other localities. The fauna as a whole does not represent the entire assemblage of the forms of the Tejon group, but only one zone appears to be present. The discovery in the type Tejon of several new species which had been described from the Washington Eocene has led to this comparison of the Washington Eocene fauna with that of the type Tejon.

This paper deals with the faunal relations of the Cowlitz phase of the Tejon group of Washington and that of the type locality of the Tejon in California. In brief, the conclusions of this comparative study are that the Cowlitz phase is in reality identical with the faunal assemblage from the typical Tejon at Cañada de las Uvas, and that both faunas belong to a middle zone of the Tejon group which will be called the Rimella simplex Zone.

HISTORICAL.

The first recognition of Eocene on the Pacific Coast was made by Conrad,[1] and was based upon the fossils contained in a boulder sent by Blake from Cañada de las Uvas.

Conrad described the following new species: *Cardium linteum, Dosinia alta, Meretrix uvasana, Meretrix californiana, Crassatella uvasana, Mytilus humerus, Volutilithes californiana, Busycon (?) blakei=(Perissolax blakei), Clavatula (?) californica=(Fusus californicus), Natica alveata=(Amauropsis alveata)*, and he identified *Venericardia planicosta, Natica ætites (?), Natica gibbosa* and *Crassatella alta* of the Claiborne Eocene.

[1] Pacific Railroad Reports, App. to Prelim. Geol. Rept. of W. P. Blake, Palaeontology, pp. 5-20, 1855. Reprinted in Pacific Railroad Reports, vol. 5, part 2, pp. 317-329, 1857.

Concerning this occurrence Conrad states that "The Eocene period is unequivocally represented, by the beautifully perfect shells from the Cañada de las Uvas, which, though not found in situ, are evidently derived from strata occurring on the Pacific slope of the Sierra Nevada. This is very remarkable, inasmuch as three species correspond with forms of Claiborne, Alabama, and seem to indicate a connection of the Atlantic and Pacific oceans during the Eocene period. The vast distance between the two localities will account for the general distinction of species, and it was indeed, an unexpected result to find any identical. If I had imagined any eastern species to occur in California, it would have been the very one which does occur, and apparently in abundance, that 'finger post' of the Eocene, *Cardita planicosta,* a fossil of the Paris Basin, and also abundant in Maryland, Virginia and Alabama. This species originated and perished in the Eocene period, and is so widely distributed that it may be regarded as the most characteristic fossil of its era. As the boulder from which these shells were derived was quite small, and yet furnished thirteen species, when it shall be investigated in situ, doubtless a great many other forms will be obtained, and very likely some with which we are already familiar in eastern localities. Although the rock is a very hard sandstone, the shells may be exposed in great perfection by careful management, and we look forward with great interest to their further development, and to the discovery of the rock in situ."

Gabb[2] in 1864 described many species which Captain Horn collected from the vicinity of Cañada de las Uvas and referred the strata yielding this fauna to Division B of the Cretaceous. Whitney[3] in the next volume described the type locality of the Tejon-Eocene as follows:

"The Tejon group . . . . the division B of Palaeontology, vol. 1, is peculiar to California. It is found most extensively developed in the vicinity of Fort Tejon and about Martinez. From the latter locality it forms an almost continuous belt in the Coast Ranges to Marshs', 15 miles east of Mount Diablo, where it sinks under the San Joaquin plain. It was also dis-

[2] Gabb, Wm., Geology of California, Palaeontology, vol. 1, 1864.
[3] Whitney, J. D., Geology of California, Palaeontology, vol. 2, p. 19 of preface, 1869.

covered by the different members of the survey at various points on the eastern face of the same range as far south as New Idria, and in the summer of 1866 by Mr. Gabb in Mendocino County, near Round Valley, the latter locality being the most northern point at which it is as yet known......".

"This group contains a large and highly characteristic series of fossils, the larger part peculiar to itself, while a considerable percentage is found extending below into the next group (Martinez)".

For several years the controversy concerning the age of the Tejon was waged. Conrad,[4] Gabb,[5] Whitney,[6] Cooper,[7] Marcou,[8] Heilprin,[9] Newberry,[10] White,[11] Becker,[12] Clark,[13] Harris,[14] Diller,[15] all contributed to this question. The cretaceous ghost of the Tejon was finally laid by Stanton[16] and Merriam.[17] Most of the papers cited deal with the Tejon in general, and direct references to the type locality are few in number.

[4] Conrad, T. A., "Observations on Certain Eocene Fossils described as Cretaceous, by W. M. Gabb in his Report published in "Palaeontology of California", Am. Jour. Conchol., vol. 1, pp. 362-365, 1865; "Further Observations on Mr. Gabb's Palaeontology of California", Am. Jour. Conchol., vol. 2, pp. 97-100, 1866; "Check list of Invertebrate Fossils of North America, Eocene and Oligocene", p. 37, Smithsonian Misc. Coll. No. 200, 1866; Am. Jour. Sci., 2nd series, vol. 44, pp. 376-377, 1867.

[5] Gabb, W. M.. Reply to Mr. Conrad's Criticism on Mr. Gabb's Report on the Palaeontology of California", Am. Jour. Conchol. vol. 2, pp. 87-92, 1866; Amer. Jour. Sci., 2nd series, vol. 44, pp. 226-229, 1867; On the Subdivisions of the Cretaceous Formation in California, Cal. Acad. Sci. Proc., 1st series, vol. 3, pp. 301-306, 1867; Geol. Surv. California, Palaeontology, vol. 2, 1869.

[6] Whitney, J. D., Geol. Surv. California, Palaeontology, vol. 2, 1869.

[7] Cooper, J. G., "The Eocene Epoch in California—Are there really no Eocene strata?", Cal. Acad. Sci. Proc., 1st series, vol. 5, pp. 419-421, 1874.

[8] Marcou, J., Am. Rept. Geog. Surv. West 100° Merid., pp. 167-169, 1876; "Note sur la geologie de la Californie", Bull. Soc. geol. France, 3rd series, vol. 11, pp. 407-435, 1883.

[9] Heilprin, A., "On the Occurrence of Ammonites in Deposits of Tertiary Age", Proc. Acad. Nat. Sci. Phila., vol. 34, p. 94, 1882; "On the Age of the Tejon Rocks of California, and the Occurrence of Ammonitic Remains in Tertiary Deposits", Proc. Acad. Nat. Sci., Phila., vol. 34, pp. 196-214, 1882.

[10] Newberry, J. S., "On Supposed Tertiary Ammonites", Proc. Acad. Nat. Sci. Phila., vol. 34, pp. 194-195, 1882.

[11] White, C. A., On Marine Eocene, Fresh Water Miocene and other fossil Mollusca of Western North America, Bull. 18, U. S. Geol. Surv., pp. 7-9, 1885.

[12] Becker, G. F., "Notes on the Stratigraphy of California", Bull. 19, U. S. Geol. Surv., pp. 1-25, 1885.

[13] Clark, Wm., "Correlation Essays, Eocene", Bull. 83, U. S. Geol. Surv., pp. 95-110, 1891.

[14] Harris, G. D., "Correlation of the Tejon with Eocene Stages of the Gulf Slope", Science, vol. 22, p. 97, 1893.

[15] Diller, J. S., Bull. Geol. Soc. Am., vol. 4, pp. 218-220, 1893.

[16] Stanton, T. W., "The Faunal Relations of the Eocene and Upper Cretaceous on the Pacific Coast", 17th Annual Report, U. S. Geol. Surv., pp. 1011-1059, 1896.

[17] Merriam, J. C., "The Geological Relations of the Martinez Group of California at the Typical Locality", Jour. Geol., vol. 5, pp. 767-775, 1897.

The reader is referred to the papers by Clark and Stanton for a more complete review of the literature concerning the age and correlation of the Tejon.

Anderson[18] mapped an area in the southern end of the San Joaquin Valley which included the Type Locality of the Tejon group and he described the stratigraphic relations there.

Weaver[19] first discovered and described the Cowlitz phase of the Tejon group in Washington. The interesting new species described by him in this paper were so numerous that the complexion of the fauna suggested that a new phase of the Eocene was discovered on the Pacific Coast and he named the rocks containing this fauna the Cowlitz formation. Since then Dr. Weaver has withdrawn this formational name, and he now recognizes these strata as a member of the enormously thick Tejon group of Washington.

Arnold and Hannibal[20] listed species from Weaver's type locality and included the strata which yielded this fauna in the "Chehalis formation, Tejon series." They state concerning the fauna of their Chehalis formation that "No equivalent strata have been recognized elsewhere in the northwest but the Tejon of the type locality near old Fort Tejon in California evidently represents the same faunal stage. In many respects the Chehalis fauna is similar to that of the succeeding Olequa formation, but the floras are markedly different, that of the Chehalis formation lacking the distinctly tropical facies of the later divisions of the Tejon, and thus affording a most characteristic feature." If the plants were found at horizons of about the same age as the marine beds then the foregoing conclusions concerning climate do not agree with the evidence of the marine shells, which indicate a warm temperate or subtropical condition. It is possible that the plant beds are not the same in age as the marine beds of the Cowlitz phase.

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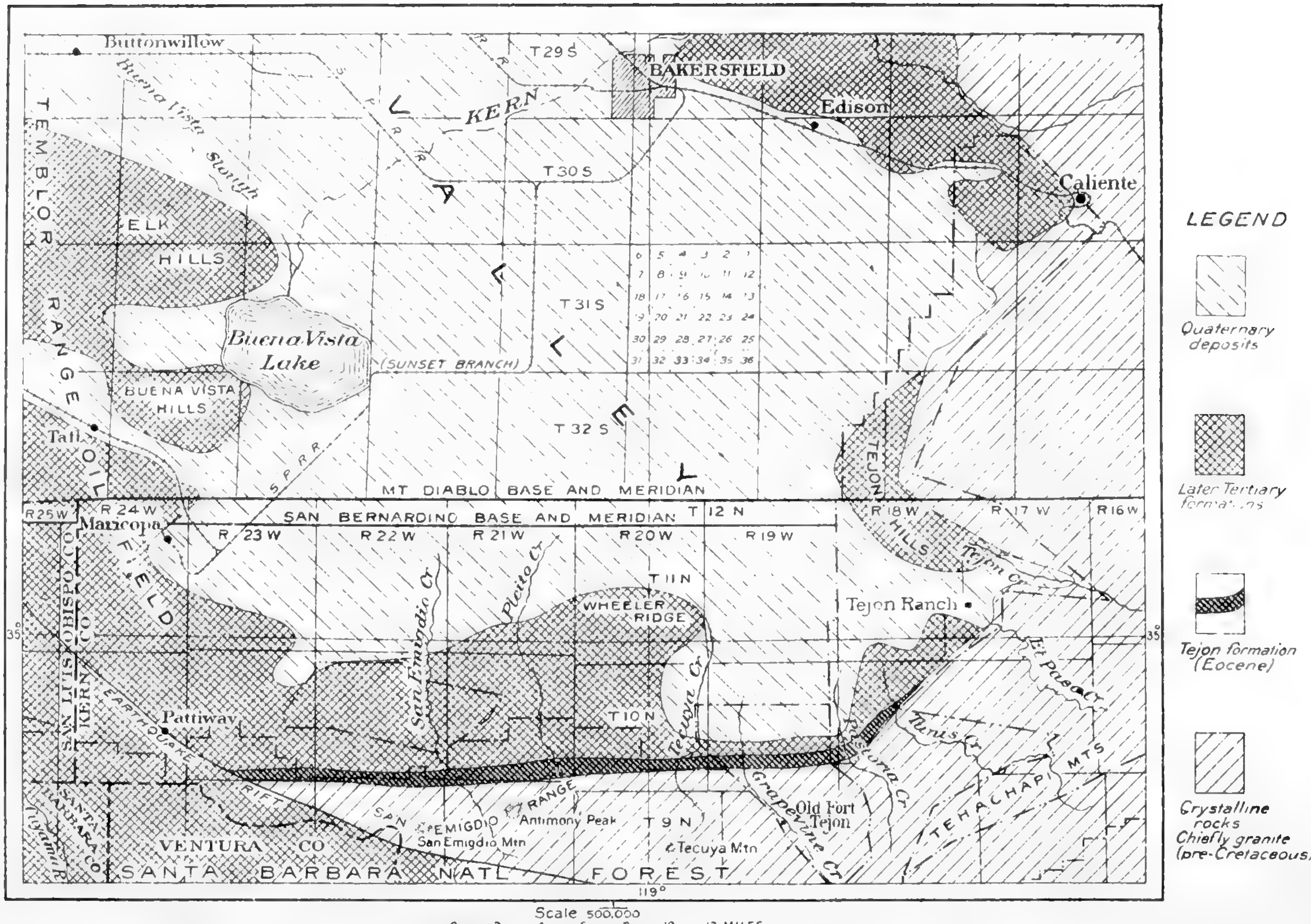
[18] Anderson, R. V., "Preliminary Report on the Geology and Possible Oil Resources of the South End of the San Joaquin Valley, Cal.", Bull. 471, U. S. Geol. Surv., pp. 117-119, 1912.

[19] Weaver, C. E., "A Preliminary Report on the Tertiary Palaeontology of Western Washington", Bull. 15, Wash. Geol. Surv., pp. 12-15, 1912.

[20] Arnold, Ralph, and Hannibal, Harold, The Marine Tertiary Stratigraphy of the North Pacific Coast of America, Proc. Am. Phil. Soc., vol. 52, pp. 567-569, 1913.



Text Figure 1.—Map of Southern End of San Joaquin Valley showing type locality of Tejon group on Grapevine Creek (After Robert Anderson).

TEJON GROUP AT TYPE LOCALITY.

STRATIGRAPHY.

The Tejon group at the type locality is a portion of an east-west strip which extends from Tunis Creek on the north flanks of the Tehachapi Mountains to a point about three miles southeast of Pattiway where it is cut off by the San Andreas Fault. The map (see Text Figure 1) which is adapted from the "Preliminary Report on the Geology and Possible Oil Resources of the South End of the San Joaquin Valley, Cal." by Robert Anderson shows the general distribution of the Tejon very satisfactorily.

The Tejon strata in the vicinity of Grapevine Creek rest upon a Basement Complex consisting of granitic rocks and associated schists. The beds in general have a steep north dip of 75° to 85°, but are disturbed in places so that the dip is reversed. The basal member, about 250 to 300 feet in thickness, consists of a very coarse conglomerate derived from the granitic rocks of the Basement Complex. This member is overlain by about 1000 to 1200 feet of thin bedded, brown sandstone with subordinate strata of dark gray, clay shale containing limestone nodules. The sandstone is, in places, conglomeritic and in one locality the dark gray pebbles of shale yielded a small *Pecten.* The occurrence of this *Pecten* suggests the deposition of earlier deposits which were completely removed during Eocene time. The uppermost strata—about 1200 feet in thickness—consist chiefly of light tan sandstone with subordinate strata of shale and brown sandstone. The total thickness of the Tejon group along Grapevine Creek (Cañada de las Uvas) is about 2500 feet. The Tejon is overlain by volcanic ash of Oligocene or Miocene age on the west side of Grapevine Creek. Mr. Bruce Martin states that the uppermost Tejon beds in Live Oak Creek are covered by a lava flow.

FAUNA

The middle portion of Tejon group in the vicinity of Grapevine Creek is particularly rich in upper Eocene species. The basal beds yielded a small fauna (Cal. Acad. Sci. locality 246) which consists of *Spondylus carlosensis, Barbatia,* sp., *Meretrix,* sp. and *Ostrea,* sp.

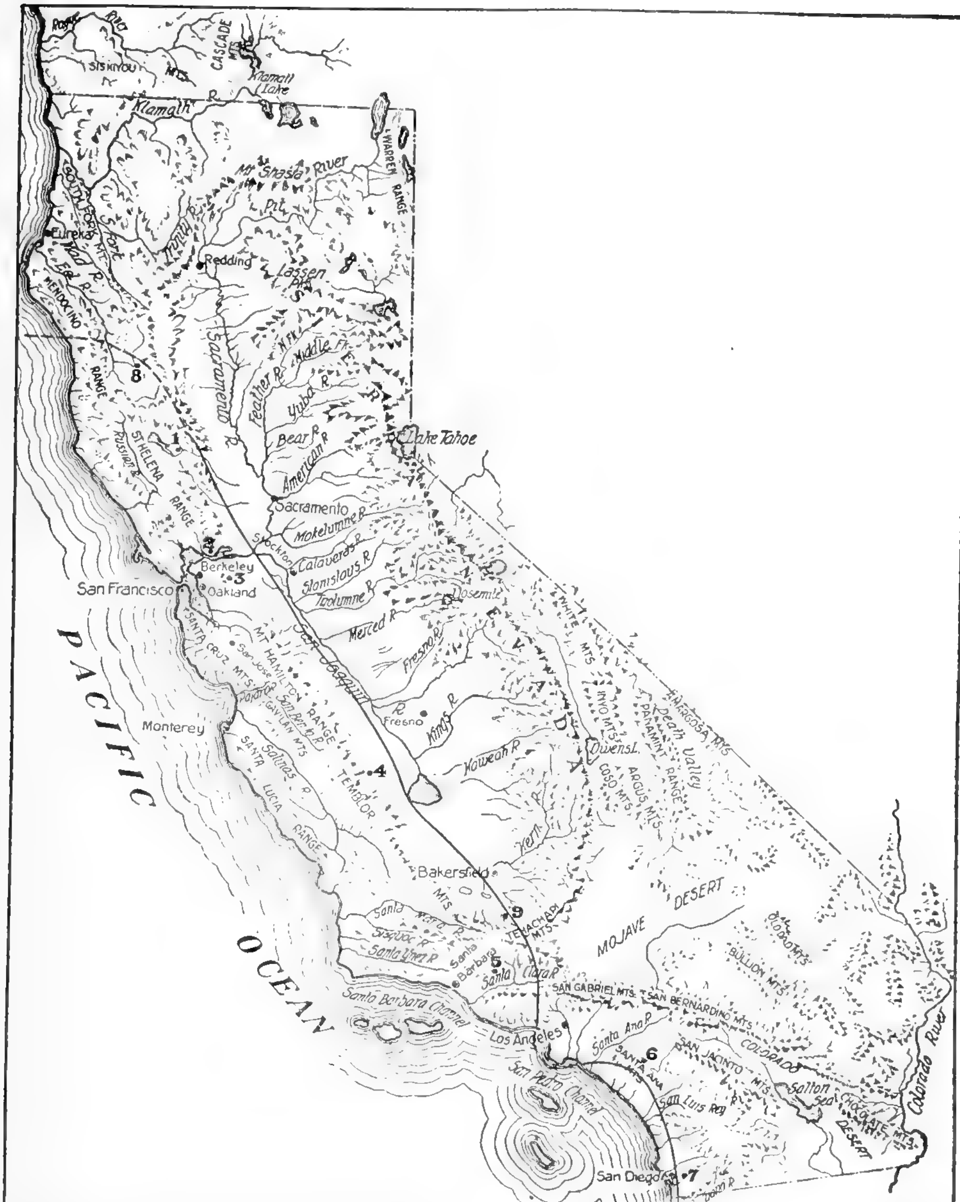
Beds about 300 feet above the base (Univ. of Cal. locality 458) yielded an excellent fauna. This fauna, however, does not differ essentially from that of the beds higher in the section. The faunas from several other localities which are listed below do not differ materially from one another but all appear to represent one phase only. This faunal unity is in consonance with the sedimentary record as Anderson[21] described it. "The beds throughout possess a marked similarity and give every appearance of representing a period of continuous deposition in one basin. They are therefore to be regarded as making up a formation, and not a larger division of the geologic column."

The writer is in complete agreement with Anderson's views as expressed here in relation to the type Tejon. However, beds both higher and lower than the Eocene of Cañada de las Uvas occur in other parts of the state, notably in the vicinity of Mount Diablo, along Cantua Creek, Coalinga Quadrangle and at the Marysville Buttes. Owing to these facts the expression —Tejon group—is fully warranted upon both stratigraphic and faunal grounds.

The fauna of the type Tejon corresponds with zone 2[22] of the Mt. Diablo section. This zone will be called henceforth, the Rimella simplex Zone, after a characteristic fossil in its fauna. It is characterized by the abundance of *Turritella uvasana, Rimella simplex, Meretrix ovalis, Macrocallista conradiana, Meretrix hornii,* and by the absence of the *Turbinolia pussilanima,* n. sp. and other species of Zone 1 of the Mount Diablo section, and *Siphonalia sutterensis, Venericardia planicosta merriami* and other members of the Siphonalia sutterensis fauna. The greatest extent of the Tejon Sea in California at this stage is represented graphically in the figure on the opposite page (see Text Figure 2). The fauna obtained from the type locality of the Tejon group is given below.

[21] Anderson, Robert, Preliminary Report on the Geology and Possible Oil Resources of the South End of the San Joaquin Valley, Cal. Bull. 471, U. S. Geol. Surv., p. 118, 1912.

[22] Dickerson, R. E. Note on the Faunal Zones of the Tejon Group, Univ. Calif. Publ. Bull. Dept. Geol., vol. 8, pp. 17-25, 1914.



TEXT FIGURE 2—Map of California showing probable extent of the Tejon Sea during the deposition of rocks which have yielded the Rimella simplex fauna. 1, Tejon at Lower Lake; 2, Tejon at Benicia; 3, Tejon vicinity of Mount Diablo; 4, Tejon of Coalinga region; 5, Tejon of the Santa Clara Valley of the South; 6, Tejon of the Santa Ana Mountains; 7, Tejon of San Diego; 8, Tejon in Round Valley, Mendocino County; 9, Type Locality of the Tejon group. This stage is the only one which is represented at San Diego and the Santa Ana Mountains.

List of Species from the Type Locality of the Tejon Group.

	244	245	246	451	452	453	454	455	456	457	458	459	460	461	462	463	464
Turbinolia, sp.				X													
Dendrophyllia tejonensis, n. sp. (Nomland ms.)											X						
Schizaster lecontei Merriam														X			
Acila, n. sp.		X			X												
Arca hornii Gabb	X																
Avicula pellucida Gabb	X						X		X				X				
Barbatia morsei Gabb						X											
Crassatellites uvasana Gabb	X	X															
Crassatellites grandis Gabb	X	X			X						X				X		
Crassatellites mathewsonii (Gabb)				X													
Cardium brewerii Gabb	X	X									X	X			X		
Cardium cooperii Gabb		X													X		
Cardium cf. olequahensis Weaver												X					
Corbula hornii Gabb	X			X	X							X					
Corbula parilis Gabb		X		X							X				X	X	
Corbula harrisi, n. sp.	X																
Corbula uvasana, n. sp.	X																
Dosinia elevata Gabb	X	X										X					
Glycimeris sagittata (Gabb)	X	X		X	X							X			X		
Glycimeris, n. sp.		X			X												
Glycimeris eocenica (Weaver)		X		X													
Glycimeris ruckmani, n.sp.					X												
Leda gabbi Conrad	X			X								X					
Leda uvasana, n.sp.	X																
Lucina cumulata Gabb	X			X													
Lucina cf. cretacea	X																
Lucina (Myrtaea), n.sp	X	X															
Lucina gyrata (Gabb)				X													
Lucina nasuta Gabb											X						
Macrocallista andersoni, n.sp.	X																
Macrocallista conradiana (Gabb)	X	X		X						X	X	X	X		X	X	
Marcia quadrata (Gabb)								X									X
Meretrix hornii Gabb	X	X		X	X			X	X	X	X	X	X				
Meretrix ovalis Gabb	X	X		X	X			X			X	X			X		X
Meretrix tejonensis, n.sp.	X	X									X	X	X			X	
Meretrix uvasana Conrad	X	X		X													
Meretrix cf. olequahensis Weaver	X																
Modiolus ornatus (Gabb)	X																
Macoma, sp.									X								
Nucula cooperi Dickerson		X															
Ostrea, sp.					X						X						
Psammobia hornii (Gabb)	X				X							X	X				
Psammobia, sp.		X															
Pinna barrowsi Dickerson					X												

Spisula merriami Packard	×											×				×	
Solen parallelus Gabb	×	×														×	
Septifer dichotomus Gabb							×										
Spondylus carlosensis Anderson			×							×							
Tellina remondii Gabb	×																
Tellina howardi, n.sp.	×																
Tellina californica Gabb	×																
Tellina joaquinensis Arnold		×															
Teredo, sp.					×												
Venericardia planicosta hornii (Gabb)	×				×						×						
Cadulus pusillus Gabb	×	×		×								×					
Dentalium stramineum Gabb	×	×		×	×						×						
Actaeon, n. sp.	×																
Amauropsis alveata (Conrad)	×	×		×	×						×	×			×		
Amauropsis andersoni Dickerson		×															
Architectonica hornii Gabb	×																
Architectonica cognata Gabb		×															
Ancillaria elongata Gabb	×	×		×								×					
Bulla hornii Gabb																	×
Cancellaria stantoni Dickerson	×	×			×						×						
Calyptræa excentrica (Gabb)	×	×			×						×			×			
Conus remondii Gabb	×																
Conus weaveri, n.sp.	×																
Conus cowlitzensis Weaver		×			×						×						
Conus hornii Gabb	×	×										×					
Conus californiana (Conrad)	×	×			×						×						
Crepidula pileum Gabb	×	×															
Cylichna costata Gabb	×	×													×		
Cypraea mathewsonii Gabb		×															
Cypraea bayerquei Gabb					×												
Cerithiopsis alternata Gabb					×												
Chrysodomus ruckmani, n.sp.				×							×						
Drillia raricostata Gabb	×	×		×													
Drillia ullreyana Cooper		×															
Exilia harrisi, n.sp.	×																
Exilia dickersoni (Weaver)		×															
Epitonium, n. sp.	×																
Fasciolaria sinuata Gabb	×	×															
Ficopsis remondii Gabb	×	×		×													
Ficopsis hornii Gabb	×	×		×	×						×						
Ficopsis cowlitzensis (Weaver)											×						
Fusus tumidus Gabb		×															
Galeodea tuberculata (Gabb)	×	×									×						
Hemifusus lewisiana Weaver		×															
Lunatia hornii Gabb	×	×			×	×					×						
Lunatia nuciformis Gabb	×	×			×							×					
Murex sopenahensis Weaver	×																
Mitra simplicissima Cooper		×		×	×												

LIST OF SPECIES FROM THE TYPE LOCALITY OF THE TEJON GROUP.—(Cont.)

	244	245	246	451	452	453	454	455	456	457	458	459	460	461	462	463	464
Mitra uvasana, n.sp.		×			×												
Naticina obliqua Gabb	×	×										×					
Natica uvasana Gabb		×			×												
Natica hannibali Dickerson															×	×	
Neverita secta Gabb	×	×		×							×	×			×		
Nyctilochus, n.sp.											×						
Nyctilochus, sp. a	×																
Nyctilochus hornii (Gabb)	×																
Nyctilochus washingtoniana (Weaver)	×	×		×	×						×						
Nyctilochus sopenahensis (Weaver)	×	×															
Nyctilochus cowlitzensis (Weaver)	×	×			×												
Nyctilochus fusiformis Gabb		×															
Nyctilochus californicus (Gabb)											×						
Olivella mathewsonii Gabb		×		×	×												
Odostomia, sp.a				×													
Odostomia, n. sp.					×												
Perissolax blakei (Conrad)	×	×		×	×						×						
Potamides, sp.	×																
Pseudoliva tejonensis, n.sp.		×			×						×						
Pseudoliva volutæformis Gabb.		×									×	×					
Rimella simplex Gabb		×										×					×
Surcula io (Gabb)	×	×															
Surcula (Surculites) sinuata Gabb	×	×			×												
Surcula cowlitzensis Weaver	×	×		×	×						×	×					
Surcula washingtoniana (Weaver)		×									×						
Siphonalia bicarinata, n.sp.																×	
Spiroglyphus (?) tejonensis Arnold		×															
Turritella uvasana Conrad	×	×		×	×							×					
Turritella uvasana bicarinata, n. var.	×											×			×		
Turritella uvasana tricarinata, n. var.	×																
Turritella, n. sp.				×	×						×				×	×	
Turritella, n. sp					×												
Terebra californica Gabb	×				×												
Turris uvasana, n.sp.		×		×	×												
Turris monolifera Cooper				×													
Turris, n. sp					×												
Turris, sp.											×						
Volutilithes n.sp.												×					
Voluta martini, n.sp.	×																
Voluta slevini, n.sp.	×																
Voluta, sp.	×																
Whitneya ficus Gabb	×	×		×							×	×				×	

LIST OF CALIFORNIA ACADEMY OF SCIENCES LOCALITIES, VICINITY OF GRAPEVINE CREEK.

244. Tejon Quadrangle, Kern County, California, Tejon group. In east bank of Live Oak Creek about three-fourths of a mile from its mouth or from the edge of the San Joaquin Valley and about three miles due east of the mouth of Grapevine Canyon. Coll., Bruce Martin.

245. Tejon Quadrangle, Kern County, California. Tejon group. Along the east bank of a small gulch about one-fourth of a mile east of the pumping plant at the mouth of Grapevine Canyon, about 35 miles south of Bakersfield, California. The fossils were found in strata at an elevation of about 2000 feet, near the middle of the Tejon section. Coll., Bruce Martin.

246. Tejon Quadrangle, Kern County, California. Tejon group. In hard conglomeritic sandstone near the top of a small hill about 300 yards west of Grapevine Canyon and about one-half of a mile south of its mouth. Elevation 2800 feet. This locality is near the base of the Tejon. Coll., Bruce Martin.

DESCRIPTIONS OF UNIVERSITY OF CALIFORNIA LOCALITIES IN THE VICINITY OF CAÑADA DE LAS UVAS (GRAPEVINE CREEK).

451. Tejon Quadrangle. Tejon group. West side of Grapevine Creek, elevation 2500 feet, T. 10 N., R. 19 W., Mt. S. B. B. L. and M., N. of center of S. W. ¼, Sec. 20; ¼ mile north of Basement Complex-Tejon contact. Coll., R. E. Dickerson.

452. Tejon Quadrangle. Tejon group. On road in Grapevine Creek; S. W. ¼ of S. E. ¼ of Sec. 20, T. 10 N., R. 19 W., Mt. S. B., B. L. and M., elevation, 2000 feet. R. E. D. 530. Coll., R. E. Dickerson.

453. Tejon Quadrangle Tejon group. Grapevine Creek; T. 10 N., R. 19 W., Mt. S. B., B. L. and M., S. W. ¼, Sec. 29. 300 feet N. of Basement Complex-Tejon Contact; R. E. D. 531. Coll., R. E. Dickerson.

454. Mt. Pinos Quadrangle. Tejon group. On Tejon-Miocene contact, ¼ mile E. of Salt Creek and 100 yards S. of

Salt Creek on ridge; T. 10 N., R. 20 W., Sec. 33, Mt. S. B., B. L., and M. on north center section line. R. E. D. 532; Avicula Bed. Colls., Roy Cohn and R. E. Dickerson.

455. Tejon Quadrangle. Tejon group. On Tecuya Creek about 1¾ miles from mouth of canon; R. E. D. 533. Colls., Roy Cohn and R. E. Dickerson.

456. Tejon Quadrangle. Tejon group. On Tecuya Creek. 200 feet S. of red agglomerate of Miocene, near top of the Tejon Group. R. E. D. 534. Colls., Roy Cohn and R. E. Dickerson.

457. Tejon Quadrangle. Tejon group. On west side of Grapevine Canyon; elevation 2100 feet; 5 miles S. 8° W. of 1085 feet B. M.; 50 to 100 feet above Basement Complex-Tejon Contact. Coll., R. E. Dickerson.

458. Tejon Quadrangle. Tejon group. West side of Grapevine Creek, elevation 2050 feet; about 4½ miles S. 6° W. of 1085 B. M.; about 400 feet (stratigraphic) above Basement Complex-Tejon contact. R. E. D. 536. Coll., R. E. Dickerson.

459. Tejon Quadrangle. Tejon group. 4¼ miles S. 9° W. of 1085 B. M., on west side of Grapevine Creek, elevation 2000 to 2100 feet. R. E. D. 537. This locality is near top of section about 1800 feet (stratigraphic) above base. Coll., R. E. Dickerson.

460. Tejon Quadrangle. Tejon group. 4 miles S. 10° W. of 1085 B. M., near top of Tejon Group; R. E. D. 538. Coll., R. E. Dickerson.

461. Tejon Quadrangle. Tejon group. 4⅛ miles S. 15° W. of 1085 B. M. at Tejon-Miocene Contact. (Schizaster lecontei Merriam) R. E. D. 539. Coll., R. E. Dickerson.

462. Mt. Pinos Quadrangle. Tejon group. On Salt Creek. S. E. ¼ of N. W. ¼, Sec. 32, T. 10 N., R. 20 W., Mt. S. B., B. L. and M., on north side of Canyon, a branch of Salt Creek, 100 feet from bottom. R. E. D. 540. Coll., R. E. Dickerson.

463. Mt. Pinos Quadrangle. Tejon group. Salt Creek. S. E. ¼ of N. W. ¼ of Sec. 32, T. 10 N., R. 20 W., Mt. S. B., B. L. and M. R. E. D. 541. Colls., B. Parsons and R. E. Dickerson.

464. Mt. Pinos Quadrangle. Tejon group. Vicinity of Salt Creek. S. E. ¼ of N. W. ¼ of Sec. 32, T. 10 N., R. 20

W., Mt. S. B., B. L. and M. on north side of a branch of Salt Creek 150 feet above bottom. R. E. D. 541. Colls., B. Parsons and R. E. Dickerson.

465. Mt. Pinos Quadrangle. Tejon group. Vicinity of Salt Creek. S. E. ¼ of N. W. ¼ of Sec. 32, T. 10 N., R. 20 W., Mt. S. B., B. L. and M., 25 feet below hilltop and 75 feet below white Miocene conglomerate. R. E. D. 543. Colls., B. Parsons and R. E. Dickerson.

COWLITZ PHASE OF TEJON GROUP.

STRATIGRAPHY.

Dr. Weaver described the Cowlitz phase as follows: "In southern Lewis County, east of Little Falls, there exist shales and shaly limestones containing a fauna seemingly older than the typical Tejon, but more closely related to it than to the Martinez or lower Eocene of California. A very large number of the species are new and the fauna may represent a transition from the Martinez to the Tejon—a fauna which as yet is unknown in California. In order to distinguish this from the typical Tejon, the term Cowlitz formation is suggested. . . . . .

The Cowlitz formation contains the following fauna:

PELECYPODA

Barbatia morsei Gabb
Cardium breweri Gabb
Cardium cooperi Gabb
Corbula, sp.
Crassatella washingtoniana, n.sp.
Crassatella cowlitzensis, n.sp.
Meretrix olequahensis, n.sp.
Ostrea fettkei, n.sp.
Pecten cowlitzensis, n.sp.
Placunanomia inornata Gabb
Venericardia alticosta Gabb
Venericardia planicosta Lamarck.

GASTROPODA

Ancillaria bretzi, n.sp.
Cassidaria washingtoniana, n.sp.
Conus cowlitzensis, n.sp.
Cylichna costata Gabb
Fusus lewisensis, n.sp.
Fusus dickersoni, n.sp.
Fusus washingtoniana, n.sp.
Galerus excentricus Gabb
Hemifusus sopenahensis, n.sp.
Hemifusus cowlitzensis, n.sp.
Hemifusus lewisensis, n.sp.
Hemifusus tejonensis, n.sp.
Hemifusus washingtoniana, n.sp.

Fasciolaria washingtoniana, n.sp.
Lunatia hornii Gabb
Murex sopenahensis, n.sp.
Murex cowlitzensis, n.sp.
Mitra washingtoniana, n.sp.
Morio tuberculatus Gabb var. trituberculatus new var.
Nassa eocenica, n.sp.
Nassa packardi, n.sp.
Naticina obliqua Gabb
Ranella washingtoniana, n.sp.
Ranella cowlitzensis, n.sp.
Rimella canalifera Gabb var. elongata new var.
Surcula cowlitzensis, n.sp.
Tritonium sopenahensis, n.sp.
Turritella uvasana Conrad.

BRACHIOPODA

Rhynconella washingtoniana, n.sp.

SHARKS' TEETH

There is a total of forty-five species occurring in this formation. Out of the total fauna thirty are new species. The base of this formation is unknown. Its known thickness is at least five hundred feet. Future studies may show this to be really a part of the Tejon formation".

Dr. Weaver's present opinion is that the Cowlitz phase is uppermost Tejon and that it is to be correlated with the Siphonalia sutterensis Zone.

Mr. Bruce Martin described conditions at the two principal collecting localities 182 and 183, Cal. Acad. Sci. as follows:

"Locality 182 is on the west bank of the Cowlitz River immediately south of the eastward bend about one and one-half miles east of Vader, Washington. This is Professor Weaver's University of Washington locality 1. The formation here consists of blue sandy clay or mudstone. There are a few prominent strata of concretionary sandstone interstratified with the clay. The strike is N. 40° W., dip 5°-10° N. The formation extends southward down the river for some distance and fossils may be obtained from the banks for a half mile or more. . . . . . The tops of the hills between Vader (Little Falls) and Olequah are mantled with basalt and the sandstone is exposed only in the creeks which have cut through the lava cap.

Locality 183 is in the west bank of the Cowlitz River about one and three-fourths miles southeast of Vader (Little Falls), Washington, about one-half mile south of Locality 182".

It will be seen from this description that Locality 183 is stratigraphically lower than Locality 182. The stratigraphy around Vader is evidently not so simple as Martin's description quoted above might lead one to infer. Martin states that the strata at locality 184, another Tejon locality on Olequah Creek one mile north of Vader have a strike of N. 35° W. and a dip of 60° E. A plot of these localities about Vader shows that some faulting or acute folding has taken place between localities 184 and 182.

FAUNA

The following species have been identified from localities 182 and 183. The ones marked by a star were reported by Dr. Weaver but are not in the Academy collections.

LIST OF SPECIES FROM COWLITZ PHASE.

	182	183	Weaver	Type Tejon
Terebratulina washingtoniana (Weaver)	×			
Acila, n.sp.		×		×
Barbatia morsei Gabb			*	×
Corbula hornii Gabb		×		×
Crassatellites Washingtoniana Weaver			*	
Crassatellites grandis (Gabb)		×		×
Crassatellites cowlitzensis (Weaver)			*	
Cardium brewerii Gabb		×		×
Cardium Cooperii Gabb			*	×
Diplodonta polita (Gabb)	×			×
Glycimeris sagittata (Gabb)		×		×
Leda gabbi Conrad	×	×		×
Leda vaderensis, n.sp.		×		
Marcia quadrata (Gabb)	×	×		×
Macrocallista(?) andersoni, n.sp.	×			×
Macrocallista vaderensis, n.sp.		×		
Meretrix olequahensis Weaver		×		×?
Meretrix cf. ovalis Gabb		×		×
Nucula, sp.	×			
Ostrea fettkei Weaver		×		
Ostrea idriaensis Gabb		×		×
Pecten cowlitzensis Weaver			*	
Psammobia, sp.		×		
Psammobia hornii (Gabb)	×			×
Placunanomia inornata Gabb			*	×
Semele (?) diaboli, n.sp.		×		
Thracia dilleri Dall		×		
Tellina sutterensis Dickerson	×			×?
Tellina longa Gabb		×		×
Teredo, sp.		×		
Venericardia planicosta hornii (Gabb)	×	×		×
Cadulus pusillus (Gabb)		×		×
Dentalium stramineum Gabb	×	×		×
Ancillaria bretzi Weaver	×	×		
Amauropsis alveata (Conrad)	×			×
Amphissa eocenica (Weaver)		×		
Amphissa packardi (Weaver)		×		
Bursa washingtoniana (Weaver)	×	×		×
Bursa cowlitzensis (Weaver)	×			×
Calyptræa excentrica (Gabb)	×	×		×
Crepidula pileum Gabb	×	×		×
Cylichna costata Gabb	×			×
Cancellaria stantoni Dickerson		×		×
Cantharus perrini, n.sp.		×		
Conus weaveri, n.sp.	×			×
Conus cowlitzensis Weaver	×			×
Conus remondii Gabb	×			×

June 15, 1915.

LIST OF SPECIES FROM COWLITZ PHASE.—(Cont.)

	182	183	Weaver	Type Tejon
Drillia ornata, n.sp.	×			
Exilia perkinsiana (Cooper)	×	×		×
Exilia dickersoni (Weaver)	×	×		×
Ficus mamillatus Gabb	×			×
Fusus washingtoniana Weaver	×			
Fusus lewisensis Weaver	×	×		
Fusus willisi, n.sp.				
Fasciolaria buwaldana, n.sp.	×			
Ficopsis cowlitzensis (Weaver)	×			×
Galeodea tuberculata (Gabb)	×			×
Hemifusus sopenahensis Weaver	×			
Hemifusus lewisiana Weaver		×		
Hemifusus washingtoniana (Weaver)	×			
Hemifusus tejonensis Weaver		×		
Lunatia cowlitzensis, n.sp.	×			
Lunatia nuciformis Gabb		×		×
Mitra washingtoniana Weaver	×	×		
Murex packardi, n.sp.	×			
Murex sopenahensis Weaver	×			×
Melania fettkei (Weaver)	×	×		
Melania packardi, n.sp.		×		
Melania vaderensis, n.sp.		×		
Monodonta wattsi Dickerson		×		
Neverita weaveri, n.sp.	×			
Neverita secta Gabb	×			×
Neritina martini, n.sp.		×		
Nerita cowlitzensis, n.sp.		×		
Naticina obliqua Gabb		×		×
Nyctilochus washingtoniana (Weaver)	×			×
Niso polito Gabb	×			×
Odostomia, n.sp		×		×
Olivella mathewsonii Gabb		×		×
Pseudoliva inornata, n.sp.		×		×
Rimella simplex Gabb	×	×		×
Rimella elongata (Weaver)	×	×		
Siphonalia bicarinata, n.sp.		×		×
Surcula washingtoniana (Weaver)	×			×
Surcula cowlitzensis Weaver	×			×
Turris pulchra, n.sp.	×			
Turris, n.sp		×		×
Turris monolifera Cooper		×		
Turris cf. monolifera Cooper		×		
Turritella uvasana Conrad	×	×		×
Turritella, n.sp	×			×
Turritella, n.sp		×		×
Triforis washingtoniana, n.sp.		×		
Urosalpinx hannibali, n.sp.	×	×		

COMPARISON OF COWLITZ AND TYPE TEJON FAUNAS

The close connection between the Cowlitz phase of the Washington Tejon and the fauna of the type Tejon is easily seen when the table of the Cowlitz fauna is studied. (See list above.) About 55 of a total of 95 species listed from Washington are found in the fauna of the type Tejon. Of the remainder, three are not specifically determined, and about 20 are represented by only one or two individuals. Such characteristic and most abundant species as *Acila gabbiana, Barbatia morsei, Corbula hornii, Crassatellites grandis, Cardium*

brewerii, Cardium cooperii, Diplodonta polita, Glycimeris sagittata, Leda gabbi, Marcia quadrata, Ostrea idriaensis, Psammobia hornii, Placunanomia inornata, Tellina longa, Venericardia planicosta hornii, Cadulus pusillus, Dentalium stramineum, Amauropsis alveata, Bursa washingtoniana, Bursa cowlitzensis, Calyptræa excentrica, Crepidula pileum, Cylichna costata, Cancellaria stantoni, Conus weaveri, Conus remondii, Conus cowlitzensis, Exilia perkinsiana, Exilia dickersoni, Ficopsis cowlitzensis, Galeodea tuberculata, Lunatia nuciformis, Murex sopenahensis, Neverita secta, Naticina obliqua, Nyctilochus washingtoniana, Niso polito, Olivella mathewsonii, Rimella simplex, Surcula washingtoniana, Surcula cowlitzensis, Turris, n. sp., *Turritella uvasana, Turritella,* n. sp., *Turritella,* n. sp., are found in both faunas. This list well illustrates the fact that characteristic, abundant species are best for correlation purposes and that a mere percentage method which does not consider the abundance of individual species is very apt to be unreliable. The faunal differences are no greater than one might expect from separation by several degrees of latitude.

SUMMARY

(1.) The fauna of the type locality of Tejon group is a unit and it corresponds to the Rimella simplex Zone of the Mount Diablo region.

(2.) The beds composing the Tejon of the type locality are likewise a formational unit, but upper Eocene strata both older and younger than these occur in other parts of California.

(3.) The Cowlitz phase of the Tejon of Washington appears to represent the same faunal facies as the fauna of the type Tejon, i. e., the Rimella simplex Zone is present in both localities.

DESCRIPTIONS OF SPECIES

Leda uvasana, new species

Plate 1, figures 2a, 2b

Shell of medium size, elongate, with a very small inconspicuous central beak; anterior dorsal margin slightly convex with a slight slope to a narrowly rounded anterior extremity; posterior dorsal margin concave, ending in a sharply pointed

rostrum; ventral margin very broadly rounded; escutcheon lanceolate, distinct; lunule indistinct. This species has less thickness than *L. gabbi* Conrad and quite a different shape. Its ribbing is somewhat finer. Figure 1, Plate 1 illustrates *L. gabbi* well and brings out the differences at a glance.

Dimensions:—Height of broken type, 10mm.; length, 18mm.; convexity, 2mm.

Type:—No. 250, and cotype, No. 251, Cal. Acad. Sci. Locality 244, Tejon Quadrangle, Kern County, California, Tejon group. In east bank of Live Oak Creek about three-fourths of a mile from its mouth or from the edge of the San Joaquin Valley, and about three miles due east of the mouth of Cañada de las Uvas (Grapevine Creek). Coll., Bruce Martin.

Named for its occurrence in the vicinity of Cañada de las Uvas.

Leda vaderensis, new species

Plate 1, figure 3

Shell robust, thick, with prominent, central beak; anterior dorsal margin slightly convex, sloping toward a well rounded anterior; posterior dorsal margin concave; ventral margin convex resembling that of *L. gabbi* closely; decoration consisting of very fine, round concentric ribs. This species differs from *L. gabbi* in its finer ribbing, in its greater convexity, and in the central position of its beak.

Dimensions:—Height, 7mm.; length, 13mm.; convexity, 2mm.

Type:—No. 252, Cal. Acad. Sci. Locality 183, in the west bank of the Cowlitz River, about one and three-fourths miles southeast of Vader, Washington. Coll., Bruce Martin.

Named for its occurrence near Vader, Washington.

Glycimeris ruckmani, new species

Plate 1, figures 5a and 5b

Shell of moderate size with acutely pointed beaks; dorsal margins sloping steeply to join a broadly rounded ventral margin; the posterior dorsal margin slightly convex and with a gentler slope than the straight anterior dorsal margin; decoration consisting of about 28 rounded radial ribs crossed by concentric growth lines; area semilunar and marked by impressed lines curving outward from the altitude line.

This species differs from *Glycimeris cor* in having a more pointed beak, in lack of hinge teeth in the central portion of its hinge and in general shape. *Glycimeris cor* Gabb is figured for comparison. (See Plate a, figure 6).

Dimensions:—Height of type, 19mm.; length, 17mm.; convexity, 6mm.

Type:—No. 11051, University of California. Locality 458, Tejon Quadrangle. Tejon group. West side of Grapevine Creek, elevation 2050 feet, about 4½ miles S. 6° W. of 1085 B. M.; about 400 feet (stratigraphically) above Basement Complex-Tejon contact. R. E. D. 536. Coll., R. E. Dickerson.

Named in honor of Mr. John Ruckman.

Meretrix tejonensis, new name

Plate 3, figures 2a and 2b

Meretrix uvasana Gabb, *not* Conrad, Gabb, W. M., Geology of California, Palaeontology, vol. 1, pp. 163-164, 1864.

Gabb's description is as follows:

"Shell thick, oval, robust, a fourth longer than wide, very inequilateral; beaks large, strongly incurved, placed less than a third of the length from the anterior end; buccal margin prominently rounded below, deeply excavated under the beaks; cardinal margin sloping very convexly towards the posterior end, which is subtruncated. Surface marked by small lamelliform ribs, separated by spaces about equal to four times the thickness of the ribs themselves; the interspaces are sometimes plain, sometimes striated. Inner margin plain.

Localities: Abundant near Fort Tejon, whence it was described by Mr. Conrad; also found not rarely, near Martinez, and nearly everywhere in Division B.

This is the largest species of the genus, and one of the commonest fossils in California. The figure given in the Pacific Railroad Report is from a fragmentary specimen, and conveys a very incorrect idea of the outline of the shell. There can be no doubt of the identity of the present form with Mr. Conrad's species, since I collected numerous specimens myself, at the original locality; and this is the only species with the peculiar surface ornamentation, mentioned by Mr. Conrad, that has been found in California."

It appears that Gabb was mistaken concerning "the only species with the peculiar surface ornamentation," as the individuals figured as figures 3a and 3b on Plate 3 show. These forms are very close to Conrad's figure of *M. uvasana,* and the writer believes that the forms illustrated are cotypes of Conrad's species. All of the four specimens figured as 2a, 2b, 3a, 3b came from Cal. Acad. Sci. locality 244. On this account the writer proposes a new name for the species redescribed by Gabb as *M. uvasana.*

Macrocallista vaderensis, new species

Plate 3, figures 5a, 5b, 5c

Shell trigonal, with beak a third of shell length from broadly rounded anterior end; posterior dorsal margin sloping to a sharply pointed posterior; broadly rounded anterior extending from beak to nearly straight ventral margin; lunule and escutcheon, indistinct. The trigonal form of this species makes it easily distinguishable from other Eocene Veneridæ.

Dimensions:—Height, 19mm.; length, 26mm.; convexity, 7mm.

Type:—No. 267, and cotype No. 268, Cal. Acad. Sci. Locality 183, in the west bank of the Cowlitz River about one and three-fourths miles southeast of Vader, Washington. Coll., Bruce Martin.

Named for its occurrence near Vader, Washington.

Macrocallista (?) andersoni, new species

Plate 4, figures 1a, 1b

Shell elliptical in outline; medium size; beak prominent, a third of shell length from anterior end; posterior dorsal margin nearly straight; posterior end subtruncate; anterior end well rounded; lunule and escutcheon distinct; a well marked shallow umbonal groove extending to the ventral margin near posterior end; hinge characters unknown; numerous lines of growth decorating shell. The umbonal groove is the unique character of this species and serves to distinguish it from other west coast venerid forms.

Dimensions:—Length, 39mm.; height, 25mm.

Type:—No. 269, Cal. Acad. Sci. Locality 244, Tejon Quadrangle, Kern County, California. Tejon group. In east bank of Live Oak Creek about ¾ mile from its mouth. Coll., Bruce Martin.

Named in honor of Mr. F. M. Anderson, Curator, Department of Invertebrate Paleontology, California Academy of Sciences.

Tellina howardi, new species

Plate 4, figures 2a and 2b

Shell large, oval, compressed; beak anterior of center; anterior and posterior dorsal margins nearly straight sloping gently; anterior end rounded more broadly than posterior; ventral margin with very great curvature. This is the largest *Tellina* in the Tejon-Eocene.

Dimensions:—Length of broken type, 43mm.; height, 30mm.

Type:—No. 271, and cotype, No. 272, Cal. Acad. Sci. Locality 244, Tejon Quadrangle, Kern County, California. Tejon group. In east bank of Live Oak Creek about three-fourths of a mile from its mouth or from the edge of the San Joaquin Valley and about three miles due east of the mouth of Grapevine Canyon. Coll., B. Martin.

Named for Delle Howard Dickerson who has aided the writer in his paleontological studies.

Semele diaboli, new species

Plate 4, figure 4

Shell of medium size; beak sub-central; anterior dorsal margin sloping gently to a well rounded anterior end; posterior dorsal margin sloping steeply to a sharply rounded posterior; decoration, concentric growth lines only.

Dimensions:—Length, 31mm.; height, 24mm.

Type:—No. 11052, University of California. Locality 469, Mount Diablo Quadrangle, Contra Costa County, California. Tejon group. Near middle of S. E. ¼ of Sec. 21, T. 1 S., R. 1 E., Mt. D. B. L. and M., elevation 1350 feet, on north side of ridge. Coll., R. E. Dickerson.

Named for the occurrence in the vicinity of Mount Diablo.

Corbula harrisi, new species

Plate 4, figure 6

Shell small, thick, subtrigonal, with beak central, slightly prosogyrate; anterior dorsal slope slightly steeper than the moderately steep posterior dorsal slope; base broadly rounded; posterior end sharply rounded; a faint umbonal slope extending to the point between the posterior end and the base; shell decorated by faint radial ribbing which is strongest at posterior end along the umbonal slope and by concentric growth lines. Interior of shell is unknown and hence generic reference is doubtful. This species is not so thick as *C. parilis* Gabb and its concentric ribbing is not so strong.

Dimensions:—Length, 6mm.; height, 4mm.; convexity, 1.5mm.

Type:—No. 275, Cal. Acad. Sci. Locality 244, Tejon Quadrangle, Kern County, California. Tejon group. In east bank of Live Oak Creek about three-quarters of a mile from its mouth. Coll., B. Martin.

Named in honor of Professor G. D. Harris of Cornell University.

Corbula uvasana, new species

Plate 4, figure 7

Shell small, inflated with central beak, anterior dorsal margin slightly concave with moderate slope to a subtruncate anterior end; posterior dorsal margin with slight slope to a broadly rounded posterior; ventral margin broadly rounded. Faint radial lines and feeble concentric growth lines decorate this shell. Interior unknown.

Dimensions:—Length, 7mm.; height, 5mm.; convexity, 2mm.

Type:—No. 276, Cal. Acad. Sci. Locality 244, Tejon Quadrangle, Kern County, California. Tejon group. In bank of Live Oak Creek about three-quarters of a mile from its mouth. Coll., Bruce Martin.

Named for its occurrence near Cañada de las Uvas.

Neverita weaveri, new species

Plate 4, figures 10a, 10b

Shell small, subglobose with very low spire of three whorls; aperture semilunar, entire; outer lip thin, curving backward; umbilicus completely covered in the type, a mature specimen, but partially open in young forms; outer lip and umbilicus in same plane which cuts axis of shell at a forty-five degree angle.

The umbilicus of this species resembles that of *N. callosa* Gabb very closely but its low spire renders it easily separable from *N. callosa.*

Dimensions:—Length, 9mm.; width of body-whorl, 11mm.

Type:—No. 278, and cotype, No. 279, Cal. Acad. Sci. Locality 183, in the west bank of the Cowlitz River about one and three-fourths miles southeast of Vader (Little Falls), Washington, about one-half mile south of Locality 182.

Named for Professor C. E. Weaver, University of Washington.

Lunatia cowlitzensis, new species

Plate 4, figures 12a, 12b

Shell of medium size, high with five rounded whorls; umbilical chink small, long, narrow; callus long, slightly widening above umbilical chink; aperture semilunar.

This species has apparently two different forms one of which is slightly higher than the other. Possibly these two forms represent sex differences.

This species has a higher spire than *L. hornii* Gabb, (See Plate 4, figure 4). It resembles *L. shumardiana* Gabb very closely but the callus appears to be slightly different.

Dimensions:—Length, 30mm.; width of body-whorl, 21mm.

Type:—No. 281, and cotype, No. 282, Cal. Acad. Sci. Locality 182, on the west bank of the Cowlitz River immediately south of the eastward bend about one and one-half miles east of Vader, Washington. This is Professor Weaver's University of Washington Locality 1.

Named for its occurrence on the Cowlitz River, Washington.

Turritella uvasana bicarinata, new variety

Plate 5, figure 2

This variety which is found associated with the typical *T. uvasana* at Cal. Acad. Sci. Locality 244 differs from the typical form in that the lower portion of the whorls are marked by two unusually strong carinæ with a thread between. Intergrades are found between this form and the typical *T. uvasana*. These two carinæ give the whorls a form somewhat similar to *T. martinezensis* of the Martinez group and quite different from the well rounded whorls of the typical *T. uvasana*.

Type:—No. 285, Cal. Acad. Sci. Locality 244, Tejon Quadrangle, Kern County, California. Tejon group. In east bank of Live Oak Creek about three-fourths of a mile from its mouth or from the edge of the San Joaquin Valley and about three miles due east of the mouth of Grapevine Canyon. Coll., Bruce Martin.

Turritella uvasana tricarinata, new variety

Plate 5, figure 4

This variety also occurs with the above described variety which it resembles closely but differs by having three strong carinæ instead of two.

Type:—No. 287, Cal. Acad. Sci. Locality 244, Tejon Quadrangle, Kern County, California. Tejon group. In east bank of Live Oak Creek about three-fourths of a mile from its mouth or from the edge of the San Joaquin Valley and about three miles due east of the mouth of Grapevine Canyon. Coll., Bruce Martin.

Nerita cowlitzensis, new species

Plate 5, figures 7a, 7b

Shell very small with spire immersed; whorls three, rapidly increasing in size; surface of subglobose body-whorl divided into three portions by a strong spiral line at the shoulder and a second medial one; mouth semilunar; outer lip thickened, dentate; callus heavy, closing umbilicus completely; beaded spiral threads crossed by axial ribs decorating shell.

This species is less angulated than *N. triangulata* Gabb and its spiral threads are beaded.

Dimensions:—Length, 7mm.; width of body-whorl, 8mm.

Type:—No. 290, Cal. Acad. Sci. Locality 183, in the west bank of the Cowlitz River about one and three-fourths miles southeast of Vader (Little Falls), Washington, about one-half mile south of Locality 182.

Named for its occurrence on Cowlitz River, Washington.

Neritina martini, new species

Plate 5, figures 8a, 8b

Shell medium in size with two and a half whorls; spire immersed; body-whorl very wide, rounded to sub-quadrate, with flattened top which is perpendicular to axis of shell; outer lip sharp, smooth within, entire; callus large with straight interior edge which is slightly dentate; surface decorated by sinuous axial growth lines.

This is the first representative of this genus reported from the West Coast Eocene.

Dimensions:—Length, 18mm.; width of body-whorl, 21mm.

Type:—No. 291, Cal. Acad. Sci. Locality 183, in the west bank of the Cowlitz River about one and three-fourths miles southeast of Vader (Little Falls), Washington, about one-half mile south of Locality 182.

Named in honor of Mr. Bruce Martin who collected the species at its type locality.

Rimella elongata (Weaver)

Plate 6, figure 2

Rimella canalifera elongata Weaver, C. E. "A Preliminary Report on the Tertiary Palaeontology of Western Washington". Bull. 15, Wash. Geol. Surv., pp. 37-38, 1912.

The specimen figured agrees with Weaver's description and since it came from the type locality of the species it is evidently the same. It differs so very much from *R. canalifera* Gabb that it was thought best to raise it to specific rank. Dr. Weaver pointed out these differences very well. "This variety is characterized by ten instead of six or seven whorls, by its more slender form, and differences in external ornamentation."

Unfortunately his figures do not correspond to the description. The number of axial ribs of this species is much greater than in *R. canalifera.* The differences between this species and *R. simplex* Gabb are readily seen upon comparing the figures. (See Plate 6, figures 1a, 1b).

Cypræa mathewsonii Gabb

Cypræa Mathewsonii Gabb, W. M., Geol. Calif. Palæontology, vol. 2, p. 164, 1868.

Plate 6, figure 5

This small form is abundant at Cal. Acad. Sci. Locality 245. It differs from *C. bayerquei* Gabb, (See Plate 6, figure 4a, 4b) in its greater thickness and in its shorter length. It is not common at most Tejon localities and as far as known it is characteristic of the Rimella simplex Zone. *Cypræa bayerquei* has apparently the same upper limit.

Melania packardi, new species

Plate 6, figure 6

Shell elongate, slender, with flat sided whorls; about twelve parallel axial ribs which are crossed by six or seven weaker spiral lines decorate each whorl; rectangular spaces between two sets of lines having greater length parallel to spiral lines; suture wavy, distinct.

This species is readily recognized by its characteristic decoration.

Dimensions:—Length of broken type, 18mm.; width of body-whorl, 8mm.

Type:—No. 299, Cal. Acad. Sci. Locality 183, in the west bank of the Cowlitz River about one and three-fourths miles southeast of Vader (Little Falls), Washington, about one-half mile south of Locality 182.

Named for Mr. Earl L. Packard who collected many specimens from this locality.

Melania vaderensis, new species

Plate 6, figure 7

Shell elongate-conic with nearly flat sided whorls; whorls decorated by seventeen or eighteen slightly sinuous axial ribs crossed by four spiral lines of nearly equal strength; suture wavy, distinct.

This species differs from *M. packardi* in the decoration of its whorls and a greater apical angle.

Dimensions:—Length of broken type, 19 mm.; width of body-whorl, 6 mm.

Type:—No. 300, Cal. Acad. Sci. Locality 183, in the west bank of the Cowlitz River about one and three-fourths miles southeast of Vader (Little Falls), Washington, about one-half mile south of Locality 182.

Named for its occurrence near Vader, Washington.

Ficopsis remondii Gabb, **Ficopsis hornii** Gabb, **Ficopsis cooperii** Gabb, **Ficopsis cowlitzensis** (Weaver)

Ficopsis remondii Gabb, W. M., Geol. Calif. Palaeontology, vol. 1, p. 87, 1864.

Ficopsis hornii Gabb, W. M., Geol. Calif. Palaeontology, vol. 1, p. 86, 1864.

Ficopsis cooperii Gabb, W. M., Geol. Calif. Palaeontology, vol. 1, p. 86, 1864.

Hemifusus cowlitzensis Weaver, C. E., Wash. Geol. Surv. Bull. 15, p. 45, 1912.

Plate 6, figures 8, 9, 10, 11, 12

This very natural group is represented in the Tejon fauna by *Ficopsis remondii* Gabb, *F. hornii* Gabb, *F. cooperii* Gabb and *F. cowlitzensis* (Weaver). Conrad also included *Ficus mamillatus* Gabb in this group as well, but it appears to belong to the genus *Ficus,* as it lacks the relatively higher spire of *Ficopsis,* its body-whorl is more globose and its outer lip has no tendency to become angulated.

Ficopsis remondii Gabb is sometimes almost without marked angulation but in general, the specimen figured (See Plate 6, figure 8) represents a typical form. This species lacks any marked nodosity at the shoulder or upon the two carinæ below it.

Ficopsis cowlitzensis (Weaver) is an intermediate form, that is, it bears certain resemblances to *F. remondii* on the one hand and to *F. hornii* on the other. It differs from *F. remondii* in that its shoulder is more definitely set off and in that the carinæ are more definite and are always nodose. Its nodes

are more numerous than those of *F. hornii,* its shoulder is more sloping and the three carinæ are equally spaced instead of having a markedly different spacing as in the other species.

Ficopsis cooperii is much closer to *F. hornii* than to other members of this genus, but its square shoulder is without even the small slope of *F. hornii,* its spiral threads are finer and the three rows of nodes are unequally spaced but in reverse order the two upper rows being the closer together.

The range of these species brings out some interesting relationships. *F. remondii, F. hornii* and *F. cowlitzensis* are associated at the type locality on the Cañada de las Uvas. *F. cooperii* and *F. remondii* are found at San Diego. The general assemblage of forms at San Diego and the type Tejon represent the same faunal zone. *Ficopsis cooperii* also occurs in the Siphonalia sutterensis Zone of Oregon. It is apparent from this distribution that these forms are not directly evolved in a simple time order, that is, one form does not appear to have originated from another but they appear to represent end members of branchings from a common ancestor of an earlier period and possibly sometime when well preserved species of this genus are found in the Martinez group, a more nearly complete history of the group may be written.

Pseudoliva inornata, new species

Plate 7, figures 1a, 1b, 1c

Shell pyriform, solid with thick shell; six whorls; the flat sided spire forming a cone which rests upon the body-whorl whose upper portion has a slightly lesser slope than the spire; body-whorl slightly swollen, elongate; suture linear; canal short, reverted; siphonal fasciole moderately developed; decoration consisting of axial growth lines only.

The lack of marked decoration and the nearly smooth surface of the shell, and the elongate form are characters which separate this species from other West Coast Eocene forms belonging to the genus *Pseudoliva.*

Dimensions:—Length, 32 mm.; width of body-whorl, 18 mm.

Type:—No. 11053, University of California. Locality 458, Tejon Quadrangle. Tejon group. West side of Grapevine Creek, elevation 2050 feet, about four and one-half miles S.

6° W. of 1085 feet B. M.; about 400 feet above Basement Complex—Tejon contact. R. E. D. 536. Coll. R. E. Dickerson.

Pseudoliva tejonensis, new species

Plate 7, figure 2

Shell pyriform, solid with thick shell substance; five whorls; the flat-sided spire whorls forming a cone which rests upon top of the body whorl; suture wavy, appressed and bordered by a rounded ridge on the body whorl; posterior sinus narrow, sharp and moderately deep; aperture oval with greatest width medial; inner lip thinly calloused; umbilicus imperforate; canal short, reverted; siphonal fasciole well developed; sulcus medial; decoration consisting of many fine spiral lines crossed by equally fine axial threads.

Dimensions:—Length, 39 mm.; width of body-whorl, 27 mm.

Type:—No. 308, Cal. Acad. Sci. Locality 245, Tejon Quadrangle, Kern County, California. Tejon group. Along the east bank of a small gulch about one-fourth of a mile east of the pumping plant at the mouth of Grapevine Canyon, about thirty-five miles south of Bakersfield, California. Coll., Bruce Martin.

Named for its occurrence in the Tejon group.

Triforis washingtoniana, new species

Plate 6, figure 13

Shell elongate, conic with nine nearly plane-sided whorls, whorls decorated by three rows of nodes made by the crossing of three strong spiral lines and about eighteen axial ribs which are parallel to axis; one or two intercalary threads occur between the horizontal rows of nodes; suture indistinct.

Dimensions:—Length, 20 mm.; width of body-whorl, 45 mm.

Type:—No. 362, Cal. Acad. Sci. Locality 183, in the west bank of the Cowlitz River about one and three-fourths miles southeast of Vader (Little Falls), Washington, about one-half mile south of Locality 182.

Named for its occurrence in Washington.

Nyctilochus kewi, new species

Plate 7, figures 5a, 5b

Shell stout, with six whorls; spire only two-fifths the length of shell; the first two whorls smooth, the third, fourth and fifth whorls slightly convex and decorated by four strong spiral lines with a thread between each two and by fourteen axial ribs which make rounded nodes at the intersections with spiral ribs; of the spiral ribs, the lower two are the strongest and they occur near the base of the whorl at the place of greatest width; decoration of the body whorl similar to the decorated spire whorls; the largest spiral rib marking the shoulder which is located two-fifths of the whorl length below its sinuous suture; the spiral ribs above and below the shoulder not as well marked as those on the upper whorls; two rounded varices extending over the whorls; these varices about 180° apart being slightly discontinuous; canal short, twisted; mouth broadly oval. This species has a shorter spire than *Bursa cowlitzensis* (Weaver) or *Bursa washingtoniana* (Weaver). Its nodes are rounded instead of pointed like those of *Bursa washingtoniana* (Weaver).

Dimensions:—Length of spire, 21 mm.; width of body whorl, 15 mm.

Type:—No. 11054, Univ. Calif. Locality 458, Tejon Quadrangle, Kern County, California. Tejon group. West side of Grapevine Creek, elevation 2050 feet about four and one-half miles S. 6° W. of 1085 B. M.; about 400 feet (Stratigraphic) above Basement Complex—Tejon contact. R. E. D. 536. Coll., R. E. Dickerson.

Named in honor of Mr. Wm. Kew, who has assisted the writer upon many occasions in investigations of the Eocene of California.

Bursa washingtoniana (Weaver)

Ranella washingtoniana Weaver, C. E., Wash. Geol. Surv. Bull. 15, p. 41, 1912.

Plate 7, figures 4, 6

This species is a variable one and weathering sometimes obscures the finest spiral lines or removes them entirely. On this account the specimens collected at the type Tejon appear to be slightly different (See Plate g, figure 4) from typical forms. Fortunately several specimens from Locality 245 are

available and the study of these forms demonstrates their identity with *Bursa washingtoniana.* One specimen from Locality 245 appears to have a slightly higher spire than the Washington forms but this specimen is a larger one than any of the forms from the north and comparative material shows that this is a variation due to growth. Younger individuals are the same in form and decoration as *B. washingtoniana.*

B. washingtoniana at the type locality of the species varies as respects the strength of nodes and position of varices. The closely allied forms *Nyctilochus californicus, N. hornii* and *N. washingtoniana* are introduced for comparison (See Plate 7, figures 7, 8, 9).

Cantharus perrini, new species

Plate 7, figures 10a, 10b

Shell small, short, stout with large inflated body-whorl marked by strong spiral lines which alternate in size; whorls six; first two smooth; third, fourth and fifth whorls flat-sided and decorated by three strong spiral lines with two of lesser strength between; body-whorl decorated by eight or nine strong spiral lines with alternating threads; aperture oval; outer lip dentate and lirate within; siphonal fasciole well developed; umbilicus subimperforate.

Dimensions:—Length, 12 mm.; width of body-whorl, 7 mm.

Type:—No. 315 Cal. Acad. Sci. Locality 183, in the west bank of the Cowlitz River about one and three-fourths miles southeast of Vader (Little Falls), Washington. Coll., Bruce Martin.

Named in honor of Professor J. Perrin Smith of Stanford University.

Chrysodomus ruckmani, new species

Plate 7, figure 11

Shell solid, spindle-shaped, with six or seven whorls; spire moderately elevated, consisting of five or six very slightly rounded whorls; whorls decorated by six to eight spiral lines with small threads in the interspaces; five incremental lines crossing the spiral lines; suture linear, distinct; body-whorl rounded and nearly twice as long as the spire; aperture large, widest in middle, and terminating in a twisted canal; outer lip simple; inner lip slightly incrusted.

June 15, 1915.

This species resembles *C. mucronata* (Gabb) in decoration but its whorls are far less rounded and its spire is much shorter.

Dimensions:—Length of imperfect type, 22 mm.; width of body whorl, 11 mm.

Type:—No. 11055, Univ. California. Locality 452, Tejon group. Cañada de las Uvas, the type locality of this group. On road to Grapevine Creek, S. W. ¼ of S. E. ¼, Sec. 29, T. 10 N., R. 19 W. Coll., R. E. Dickerson.

Named for John Ruckman, who assisted the writer in identifying the fauna of this locality.

Siphonalia bicarinata, new species

Plate 8, figures 1a, 1b, 1c, 1d

Shell, fusiform; whorls seven, decorated by two spiral rows of twelve nodes; shoulder of whorl distinct, nodose; portion between shoulder and wavy suture marked by spiral threads of sub-equal strength; portion below shoulder marked by ribs of variable strength; body-whorl large, with biangular outer lip.

The two rows of nodes of this species make it easily separable from *Siphonalia suttcrensis* Dickerson. The young individuals exhibit less accentuated characters than the older. (See figures 1c, 1d.)

Dimensions:—Length, 20 mm.; width of body-whorl, 11 mm.

Type:—No. 316, and cotype, No. 317, Cal. Acad. Sci. Locality 183, in the west bank of the Cowlitz River about one and three-fourths miles southeast of Vader (Little Falls), Washington, about one-half mile south of locality 182. Coll., B. Martin.

Molopophorus tejonensis, new species

Plate 8, figures 3a, 3b

Shell biconical with very short recurved canal; spire short, with five flat sided whorls; suture distinct, linear; bordered by a narrow but distinct collar; decoration of each spire whorl consisting of about seven spiral lines crossed by about thirty slightly sinuous lines; axial ribs, sub-equal in strength; small rounded nodes present at crossing of two sets of lines; decoration of body whorl similar except for three closely spaced

spiral lines which are found in the slight concavity of the body-whorl just below the suture; siphonal fasciole of two sharp ridges with smooth channel between; aperture semioval; outer lip thin, sharp; inner lip covered by a thin callus.

This species lacks the sharp axial ribs of *Molopophorus striata* (Gabb) but its spiral decoration is more pronounced. (See Plate 8, figure 3c for comparison.) Only one specimen of *M. striata* was found and that one is evidently immature. If more comparative material were available possibly it might be shown that *M. tejonensis* is merely a mature form of *M. striata,* but it was thought best to describe *M. tejonensis* as a new species as its characters are markedly different.

Dimensions:—Length, 20 mm.; width of body-whorl, 11 mm.

Type:—No. 320, Cal. Acad. Sci. Locality 245, along the east bank of a small gulch about one-fourth of a mile east of the pumping plant at the mouth of Grapevine Canyon, about 35 miles south of Bakersfield, California. Col., Bruce Martin.

Named for its occurrence in the Tejon group at its type locality.

Hemifusus sopenahensis Weaver

Hemifusus sopenahensis Weaver, C. E., Wash. Geol. Surv. Bull. 15, p. 44, 1912.

Plate 8, figures 2a, 2b

The young individuals of this species have characters like the genus *Nyctilochus.* The body-whorl in mature forms is more elongate and the axial ribbing less pronounced.

Hemifusus volutæformis, new species

Plate 8, figures 4a, 4b

Shell small, solid, with five or six distinctly angulated whorls; whorls of the spire decorated by thirteen or fourteen axial ribs and by equally spaced spiral lines. The shoulder of the penultimate whorl which is well preserved located at a point two-fifths the whorl-length below the suture; the slope between the appressed suture and the shoulder concave and covered by spiral lines; the body-whorl decorated similarly to the spire-

whorls; shoulder of the body-whorl only a slight distance below the suture; aperture, elongate-oval and widest at shoulder; canal slightly twisted.

Dimensions:—Length, 16 mm.; width of body whorl, 8 mm.

Type:—No. 11056, University of California. Locality 452, Tejon group, Cañada de las Uvas. On road in Grapevine Creek, S. W. ¼ of S. E. ¼, Sec. 29, T. 10 N., R. 19 W. Coll., R. E. Dickerson.

Exilia waringi, new species

Plate 9, figure 3

Shell elongate-fusiform; number of whorls unknown; penultimate whorl marked by a concave surface just above middle; lower half of whorl nearly flat and parallel to the axis; decoration of lower half of whorl consisting of five closely spaced spiral lines crossed by about twenty axial, sinuous, ribs which become obsolescent near base of whorl; upper half of whorl decorated by three spiral lines with alternating threads crossed by strong axial ribs; body-whorl with similar decoration; aperture elongate-oval; outer lip simple; inner lip marked by five or six very faint lirations (?).

This species resembles *Cordiera microptygma* Gabb but the axial ribs are different in number and the form of whorl is not convex. The markings on the inner lip of *E. waringi* are probably spiral lines only and not lirations characteristic of the genus *Cordiera.*

Dimensions:—Length of broken type, 12 mm.; width of body-whorl, 4 mm.

Type:—No. 328, Cal. Acad. Sci. Locality 244, Tejon Quadrangle, Kern County, California, Tejon group. In east bank of Live Oak Creek about three-fourths of a mile from its mouth or from the edge of the San Joaquin Valley and about three miles due east of the mouth of Grapevine Canyon. Coll., Bruce Martin.

Named in honor of Mr. C. A. Waring of the California State Mining Bureau.

Whitneya ficus Gabb

Whitneya ficus Gabb, W. M., Geol. Calif. Palaeontology, vol. 1, p. 104, 1864.

Plate 9, figures 5a, 5b, 5c, 5d

This very characteristic Tejon species proves to be a form which varies greatly according to the stage of growth. The collection made by Mr. Martin at Cañada de las Uvas contains an excellent series which show growth stages very well. A young individual is marked by strong, quadrate axial ribs with flat interspaces of the same width while a youthful form is smooth on the back and has the quadrate ribs only on the body-whorl near the inner lip. A mature specimen is nearly smooth and is marked by faint spiral and axial threads only. Mature specimens differ somewhat in proportions. These may be sex differences.

Murex packardi, new species

Plate 9, figures 6a, 6b

Shell of medium size, fusiform, with five decidedly convex whorls; varices about three to each whorl but irregularly spaced; varices very characteristically ruffled; about twelve large, rugose, spiral lines cross the slightly sinuous varices; two well marked axial, nodose ribs found between the varices on body-whorl; canal nearly closed, narrow, twisted slightly to right.

Dimensions:—Length, 41 mm.; width of body-whorl, 25 mm.

Type:—No. 333, Cal. Acad. Sci. Locality 183, in the west bank of the Cowlitz River about one and three-fourths miles southeast of Vader (Little Falls), Washington, about one-half mile south of Locality 183. Coll., B. Martin.

Named in honor of Mr. Earl L. Packard whose collections at type locality of this species have greatly aided the writer.

Urosalpinx hannibali, new species

Plate 9, figures 7a, 7b

Shell fusiform with ten beautiful nearly continuous rounded axial ribs; whorls seven or eight in number, very convex and decorated by spiral lines which alternate in strength and by rounded ribs; aperture rounded, suddenly contracted

below into a short, narrow, twisted canal; inner lip slightly calloused.

Dimensions:—Length, 16 mm.; width of body whorl, 8 mm.

Type:—No. 334, Cal. Acad. Sci. Locality 182, on the west bank of the Cowlitz River immediately south of the eastward bend about one and one-half miles east of Vader, Washington. This is Professor Weaver's University of Washington locality 1. Coll., B. Martin.

Named for Mr. Harold Hannibal.

Sucula cohni, new species

Plate 10, figure 1

Shell of moderate size; whorls decorated by about twenty rounded nodes crossed by backward bowing sinuous growth lines which indicate the former central position of the sinus; a narrow collar just below a wavy impressed suture marking each whorl; space between collar and nodose central shoulder markedly concave; spiral ornamentation consisting of numerous spiral lines which alternate in size; aperture elongate-oval; outer lip simple; inner lip slightly calloused.

Dimensions:—Length of broken type, 22 mm.; width of body-whorl, 8 mm.

Type:—No. 336, Cal. Acad. Sci. Locality 245, along the east bank of a small gulch about one-fourth of a mile east of the pumping plant at the mouth of Grapevine Canyon, about 35 miles south of Bakersfield, California. Coll., B. Martin.

Named in honor of Mr. Roy Cohn who accompanied the writer to the type locality.

Surcula (Surculites) sinuata Gabb

Plate 10, figures 2a, 2b, 2c

Conus sinuatus Gabb, W. M., Geology of California, Palaeontology, vol. 1, p. 123, 1864.

Surcula (Surculites) sinuata Gabb, W. M., Geology of California, Palaeontology, vol. 2, pp. 150-151, 1869.

This species is another form which varies with its growth stages. The young individuals are slenderer and are marked by medium sized spiral lines which become obsolete in mature forms.

Drillia ornata, new species

Plate 10, figure 3

Shell elongated, fusiform; spire high; whorls eight, angular; suture distinct; surface marked by ten to twelve large rounded oblique ribs most prominent at shoulder and below, becoming obsolete above; these are crossed by numerous prominent, spiral ribs with very narrow interspaces; sinus located very slightly above shoulder; aperture elongate, wide above, narrow below.

This shell resembles *D. raricostata* Gabb in shape but its axial ribs are more numerous and its whorls are more angular.

Dimensions:—Length, 17 mm.; width of body-whorl, 6 mm.

Type:—No. 337, Cal. Acad. Sci. Locality, 182, on the west bank of the Cowlitz River immediately south of the eastward bend about one and one-half miles east of Vader, Washington. Coll., B. Martin.

Turris pulchra, new species

Plate 10, figures 4a, 4b

Shell fusiform with nine whorls; first four turbo-form, smooth; others sharply angulated by a shoulder a third of whirl below suture; decorated by twelve to fourteen sub-equal spiral lines which are slightly nodose where the fine sinuous axial ribs cross them; a beaded sutural collar occurring just below indistinct suture; aperture elongate with greatest width above, narrowing below into a slender canal; outer lip, thin; inner lip but slightly calloused.

Dimensions:—Length, 20 mm.; width of body-whorl, 6.5 mm.

Type:—No. 338, Cal. Acad. Sci. Locality 182, on the west bank of the Cowlitz River immediately south of the eastward bend about one and one-half miles east of Vader, Washington. Coll., B. Martin.

Surcula uvasana, new species

Plate 10, figure 10

Shell, spindle-shaped with seven or eight whorls; decoration of the penultimate whorl consisting of a tabulate, nodose, medial carina, two nodose spiral lines of equal strength below

the carina, a nodose spiral thread on the tabulation above the shoulder and a nodose spiral line above the carina and close to the wavy suture; body-whorl marked by a strong carina at the shoulder and by a nodose spiral line in its middle where a second angulation occurs; twelve to fifteen nodose spiral lines occurring in addition to these two prominent lines described above; mouth oval; outer lip simple. This species is easily recognizable on account of its nodose spiral lines.

Dimensions:—Length of broken type specimen, 22 mm.; width of body-whorl, 7 mm.

Type:—No. 11057, University of California. Locality 458, Tejon Quadrangle, Tejon group, west side of Grapevine Creek, elevation 2050 feet, about 4½ miles S. 6° W. of 1085 B. M. about 400 feet (stratigraphic) above Basement Complex-Tejon Contact. Coll., R. E. Dickerson.

Named for its occurrence at the type locality of the Tejon on the Cañada de las Uvas.

Surcula io (Gabb)

Plate 10, figure 11

Fasciolaria io Gabb, W. M., Geology of California, Palaeontology, vol. 1, p. 101, 1864.

This species was described as a *Fasciolaria* but careful examination fails to reveal any traces of plications and the position of the sinus is that of the genus *Surcula.*

This species belongs to the same general section of *Surcula* as *Surcula washingtoniana* (Weaver), (See Plate 10, figures 7a, 7b), but details of sculpture readily separate them.

Fusus washingtoniana Weaver

Fusus washingtoniana Weaver, C. E., Wash. Geol. Surv. Bull. 15, p. 50, 1912.

Plate 9, figure 8

The beautiful specimen figured is larger and more nearly perfect than Weaver's type. It is very close to *Fusus merriami* Dickerson (ms.) of Siphonalia sutterensis Zone of the Marysville Buttes, but it differs somewhat in proportion and details of sculpture.

Fusus willisi, new species

Plate 11, figures 1a, 1b

Shell elongate-conic; number of whorls unknown; whorls convex, decorated by twelve nearly continuous axial ribs made nodose by intersection of eight strong, spiral lines; suture wavy, distinct; aperture elongate-oval; outer lip simple; inner lip slightly incrusted.

Dimensions:—Length of broken type, 17.5 mm.; width of body-whorl, 7 mm.

Type:—No. 345, Cal. Acad. Sci. Locality 182, on the west bank of the Cowlitz River immediately south of the eastward bend about one and a half miles east of Vader, Washington. Coll., B. Martin.

Named in honor of Mr. Bailey Willis of the United States Geological Survey whose excellent detailed mapping in Washington has greatly aided workers in this field.

Fasciolaria buwaldana, new species

Plate 11, figures 2a, 2b

Shell, fusiform with probably eight convex whorls; whorls slightly shouldered a short distance below a wavy, impressed suture; spire-whorls decorated by nine axial ribs crossed by seven, very wavy, spiral lines of equal size; body whorl decoration similar except that the spiral lines over the widest part of whorl alternate in strength; aperture elongate-oval, widest in middle, narrowing below into a slightly sinuous canal of medium length. This species also occurs at Cal. Acad. Sci. Locality 245.

Dimensions:—Length, 19.5 mm.; width of body-whorl, 7.5 mm.

Type:—No. 346, Cal. Acad. Sci. Locality 182, on the west bank of the Cowlitz River immediately south of the eastward bend about one and one-half miles east of Vader, Washington. Coll., B. Martin.

Named for Mr. John P. Buwalda who spent a season collecting in the Washington formations for the California Academy of Sciences.

Fasciolaria sinuata Gabb

Fasciolaria sinuata Gabb, W. M., Geology of California, Palaeontology, vol. 1, p. 101, 1864.

Plate 11, figures 3a, 3b

This species is slightly more robust in young individuals than in older forms. The characteristic lirations in this species can only be discerned as a rule by breaking a specimen so that the spire portion of the columella can be examined, as the lirations on the outer lip are lacking. This form is very abundant at the type locality of the Tejon.

Conus californiana (Conrad)

Plate 11, figure 6

Volutilithes californiana Conrad, Pacific R. R. Report, vol. 5, p. 322, 1855.

Not Conus remondii Gabb, Rept. Geol. Surv. of California, Palaeontology, vol. 2, p. 122, 1869.

The specimen figured is without much doubt Conrad's form. Gabb described another Conus as *C. remondii* and placed this species in synonymy. Gabb's collections from the type Tejon were evidently not as exhaustive as he thought as he failed to find other forms which Conrad described.

This species has fewer nodes than *C. remondii* (See Plate 11, figure 7) and its spire height is greater. It differs from *C. cowlitzensis* Weaver (See Plate 11, figure 8) in having a shorter spire and a lesser number of nodes. The space between the suture and shoulder of this form is nearly flat while the corresponding space on *C. cowlitzensis* is decidedly concave.

Conus weaveri, new species

Plate 11, figure 10

Shell small, wide, short, with six whorls; decoration consisting of numerous spiral lines most prominent on lower part of body-whorl.

This species is easily distinguished from *C. hornii* (See Plate 11, figures 9a, 9b, 9c) by its greater breadth and by its marked spiral lines. Its lack of nodes renders it easily separable from *C. cowlitzensis, C. californiana,* and *C. remondii.*

Dimensions:—Length, 15.5; width of body-whorl, 9.5 mm.

Type:—No. 356, Cal. Acad. Sci. Locality 182, on the west bank of the Cowlitz River immediately south of the eastward bend about one and one-half miles east of Vader, Washington. Coll., B. Martin.

Named in honor of Professor C. E. Weaver.

Mitra uvasana, new species

Plate 11, figures 13a, 13b

Shell of medium size; elongate, spindle-shaped, the spire being a third the total length of shell; spire-whorls, probably eight or nine in number, flat sided, increasing slowly in size; suture impressed; body-whorl slightly convex with constriction three-fourths of whorl-length below suture; shell decorated by many fine ribbon-like spiral ribs. This species differs from *Mitra washingtoniana* Weaver and *M. simplicissima* Cooper in the greater length of spire and its marked ribbing.

Dimensions:—Length, 29 mm.; width of body-whorl, 11 mm.

Type:—No. 358, Cal. Acad. Sci. Locality 245, Tejon Quadrangle, Tejon group. Along the east bank of a small gulch about one-fourth of a mile east of the pumping plant at the mouth of Grapevine Canyon, about 35 miles south of Bakersfield, Cal. Coll., B. Martin.

Voluta slevini, new species

Plate 11, figure 16

Shell fusiform, with very rounded body-whorl; number of whorls unknown; decoration on body-whorl consisting of ten to fifteen strong spiral lines crossed by twenty axial ribs of equal strength; rounded nodes found at crossing of two sets of decoration; aperture oval; outer lip thin; inner lip bearing at least five plaits of equal size.

Dimensions:—Width of body-whorl, 9 mm.

Type:—No. 362, Cal. Acad. Sci. Locality 244, Tejon Quadrangle, Kern County, California, Tejon group. In east bank of Live Oak Creek about three-fourths of a mile from its mouth or from the edge of the San Joaquin Valley and about three miles due east of the mouth of Grapevine Canyon. Coll., B. Martin.

Named for Mr. Joseph R. Slevin, assistant curator of herpetology, Cal. Academy of Sciences, who assisted Mr. Bruce Martin in collecting at the type locality.

Voluta martini, new species

Plate 11, figures 14a, 14b

Shell large, nodose; number of whorls unknown; penultimate whorl decorated by eight or nine sharply pointed nodes which are situated on a shoulder two-thirds of the whorl-length below a wavy irregular suture; space between these nodes and the suture of the preceding whorl smooth and slightly concave; body-whorl elongate with shoulder situated about one-fourth of whorl-length below suture; shoulder decorated by eight nodes similar to those of the penultimate whorl; body-whorl decorated by growth lines only; mouth elongate, oval; outer lip simple; inner lip marked by four strong folds, the anterior fold being the strongest; canal short, twisted. This species is easily distinguished from *V. lawsoni* Dickerson by its more elongate form. Two specimens were found by Mr. Martin.

Dimensions:—Length of broken specimen, 38 mm.; width of body-whorl, 20 mm.

Type:—No. 360, Cal. Acad. Sci. Locality No. 244, in the east bank of Live Oak Creek about three-quarters of a mile from its mouth. This locality is about three miles due east of the mouth of Grapevine Canyon, Tejon group, vicinity of Type Locality. Coll., Bruce Martin, for whom the specimen is named.

Voluta, species

Plate 11, figure 15

An immature form which is apparently new was found at Cal. Acad. Sci. Locality 244. The whorls of this form are decorated by twenty sharp axial ribs crossed by equally spaced spiral threads. Four very prominent plaits are formed on the inner lip. Length of specimen is 7 mm.

EXPLANATION OF PLATE 1

Fig. 1. Leda gabbi Conrad, ×3. Figured specimen is from University of California Locality 672.

Fig. 2a. Leda uvasana, new species, ×2. Type.

Fig. 2b. Leda uvasana, new species, ×2.

Fig. 3. Leda vaderensis, new species, ×2. Type.

Fig. 4. Arca hornii Gabb, ×2. A common species in the Tejon group. Figured specimen is from University of California Locality 672.

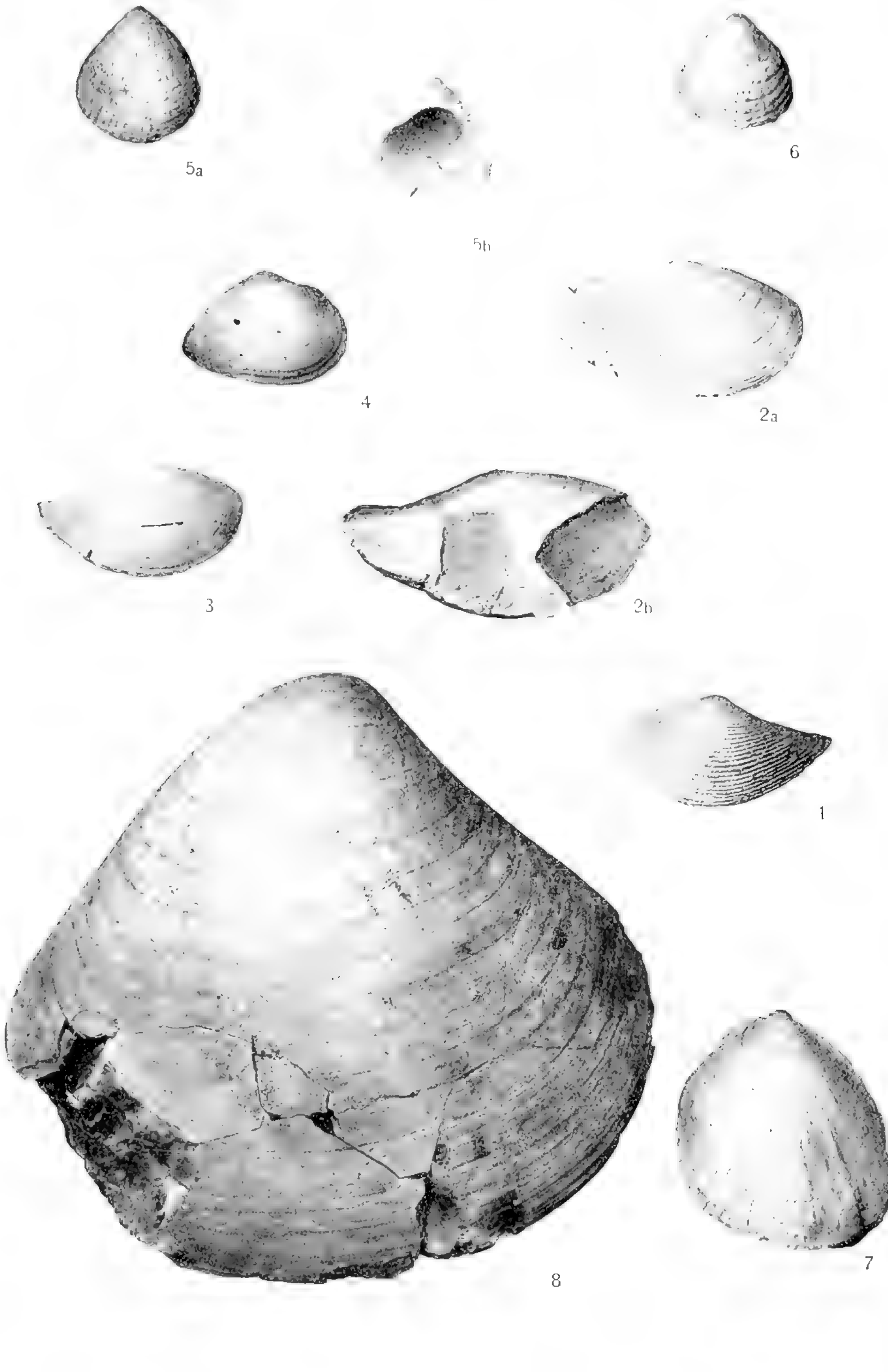
Fig. 5a. Glycimeris ruckmani, new species, ×1. Type.

Fig. 5b. Glycimeris ruckmani, new species, ×1.

Fig. 6. Glycimeris cor Gabb, ×1. This is an unusually large specimen of this species and is introduced for comparison with *G. ruckmani*, new species.

Fig. 7. Spondylus carlosensis Anderson, ×1. This is one of the few species from basal beds of the Tejon group, type locality.

Fig. 8. Crassatellites grandis Gabb, ×1. This species is also found in the Martinez group, lower Eocene. It is very abundant at some Tejon localities and is one of the few large pelecypods in the Tejon fauna.


5a
5b
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2a
3
2b
1
8
7

EXPLANATION OF PLATE 2

Fig. 1a. Crassatellites grandis Gabb, ×1. The specimen figured is from California Acad. Sci. Locality 183.

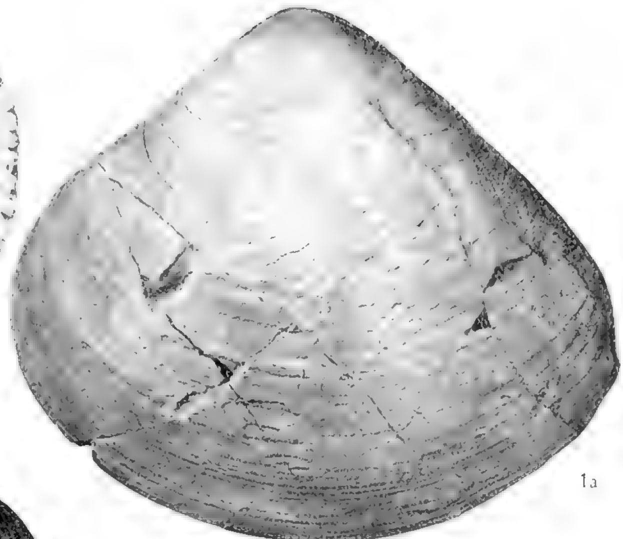
Fig. 1b. Crassatellites grandis Gabb, ×1. View showing hinge of specimen figured as Fig. 1a.

Fig. 2. Crassatellites uvasana Gabb, ×2. Figured specimen from Cal. Acad. Sci. Locality 245, is a common Tejon species.

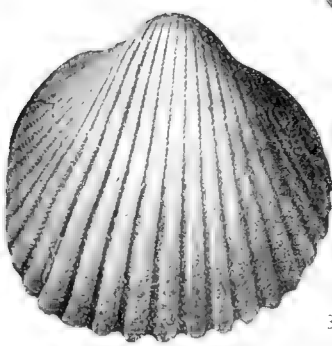
Fig. 3a. Cardium breweri Gabb, ×2. This specimen from Cal. Acad. Sci. Locality 183 is slightly longer than the species found at Cañada de las Uvas. It may prove to be a subspecies.

Fig. 3b. Cardium breweri Gabb, ×2. Hinge view of specimen figured as Fig. 3a.

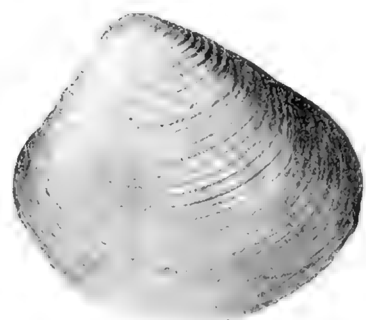
Fig. 4. Lucina cumulata Gabb, ×3. This species probably belongs to the genus *Divaricella* but since its hinge is unknown it is thought best to let the old reference remain until better material is found.



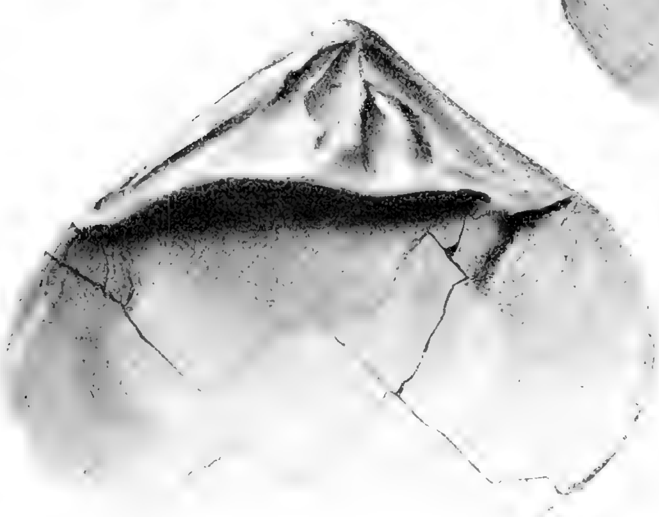
1a



3a



2



1b

4

EXPLANATION OF PLATE 3

Fig. 1a. Macrocallista conradiana (Gabb), ×2. This species was described as *Tapes conradiana*. It is a very common form throughout the Tejon group of California. The figured specimen is from Cal. Acad. Sci. Locality 244.

Fig. 1b. Macrocallista conradiana (Gabb), ×2. Umbone view of specimen from Cal. Acad. Sci. Locality 244.

Fig. 1c. Macrocallista conradiana Gabb, ×1. Hinge view of large specimen from Locality 244.

Fig. 2a. Meretrix tejonensis, n. nom., ×1.

Fig. 2b. Meretrix tejonensis, n. nom., ×2. This species was identified and redescribed by Gabb as *Meretrix uvasana* Conrad but he really had not obtained Conrad's cotype.

Fig. 3a. Meretrix uvasana Conrad, ×1. Figured specimen is from Cal. Acad. Sci. Locality 244.

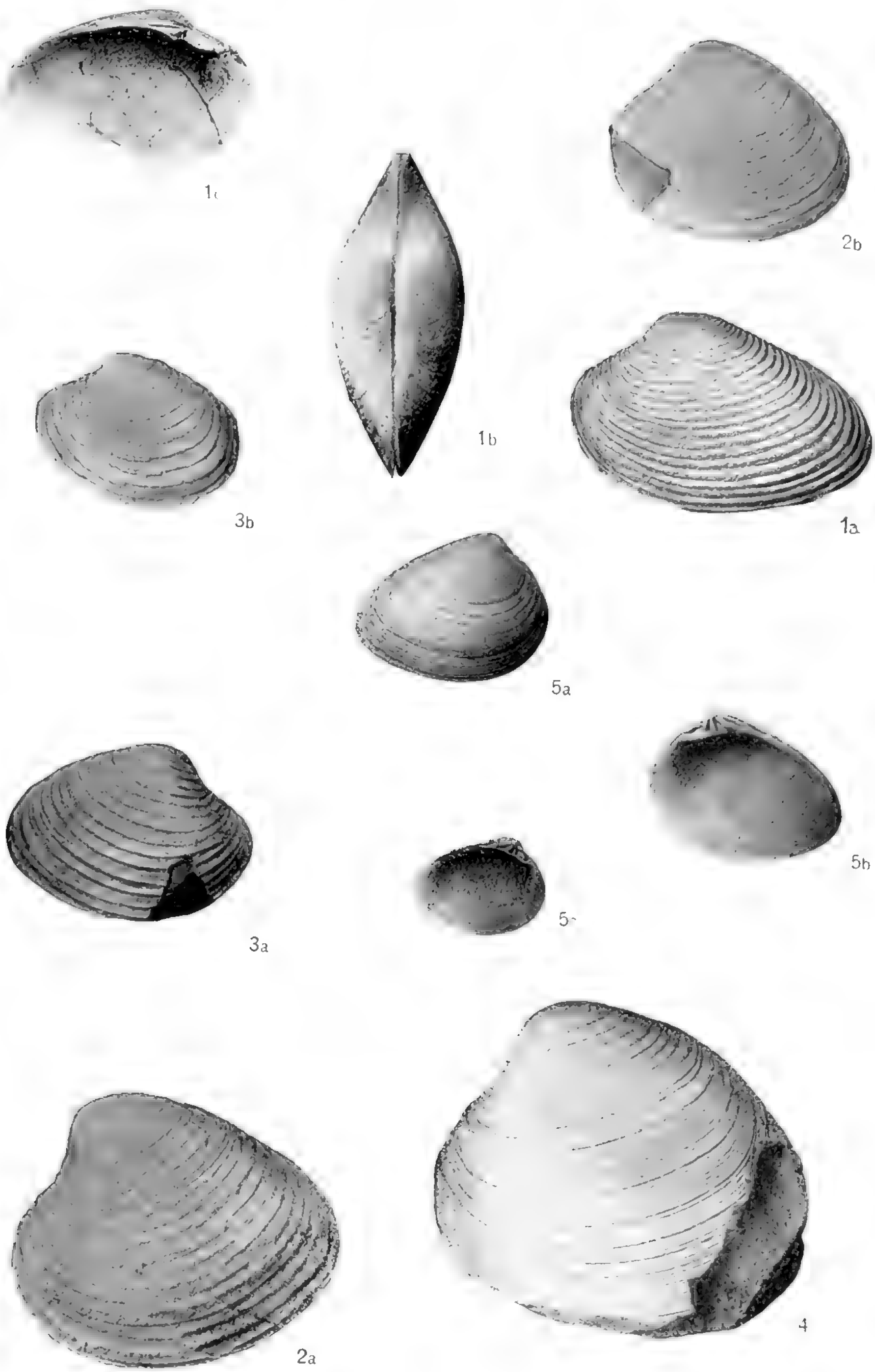
Fig. 3b. Meretrix uvasana Conrad, ×1.

Fig. 4. Meretrix ovalis Gabb, ×1. From Cal. Acad. Sci. Locality 245.

Fig. 5a. Macrocallista vaderensis, new species, ×1. Type. From Cal. Acad. Sci. Locality 183.

Fig. 5b. Macrocallista vaderensis, new species, ×1. View showing interior of type specimen.

Fig. 5c. Macrocallista vaderensis, new species, ×1. View of interior of a small left valve from Cal. Acad. Sci. Locality 183.


2b
1b
3b
1a
5a
5b
3a
2a
4

EXPLANATION OF PLATE 4

Fig. 1a. Macrocallista (?) andersoni, new species, ×1. Type.

Fig. 1b. Macrocallista andersoni, new species, ×1. Umbone view of species from Cal. Acad. Sci. Locality 183, Cowlitz phase, Washington.

Fig. 2a. Tellina howardi, new species, ×1. Type.

Fig. 2b. Tellina howardi, new species, ×1.

Fig. 3. Tellina californica Gabb, ×2.

Fig. 4. Semele diaboli, new species, ×1. Type.

Fig. 5a. Corbula hornii Gabb, ×2. This species is introduced for comparison with *Corbula harrisi,* new species, and *Corbula uvasana,* new species.

Fig. 5b. Corbula hornii Gabb, ×2. Interior of same specimen figured as Fig. 5a.

Fig. 6. Corbula harrisi, new species, ×2. Type.

Fig. 7. Corbula uvasana, new species, ×2. Type.

Fig. 8. Corbula parilis Gabb, ×2. View of specimen from Marysville Buttes Tejon.

Fig. 9. Neverita secta Gabb, ×1. From Cal. Acad. Sci. Locality 182.

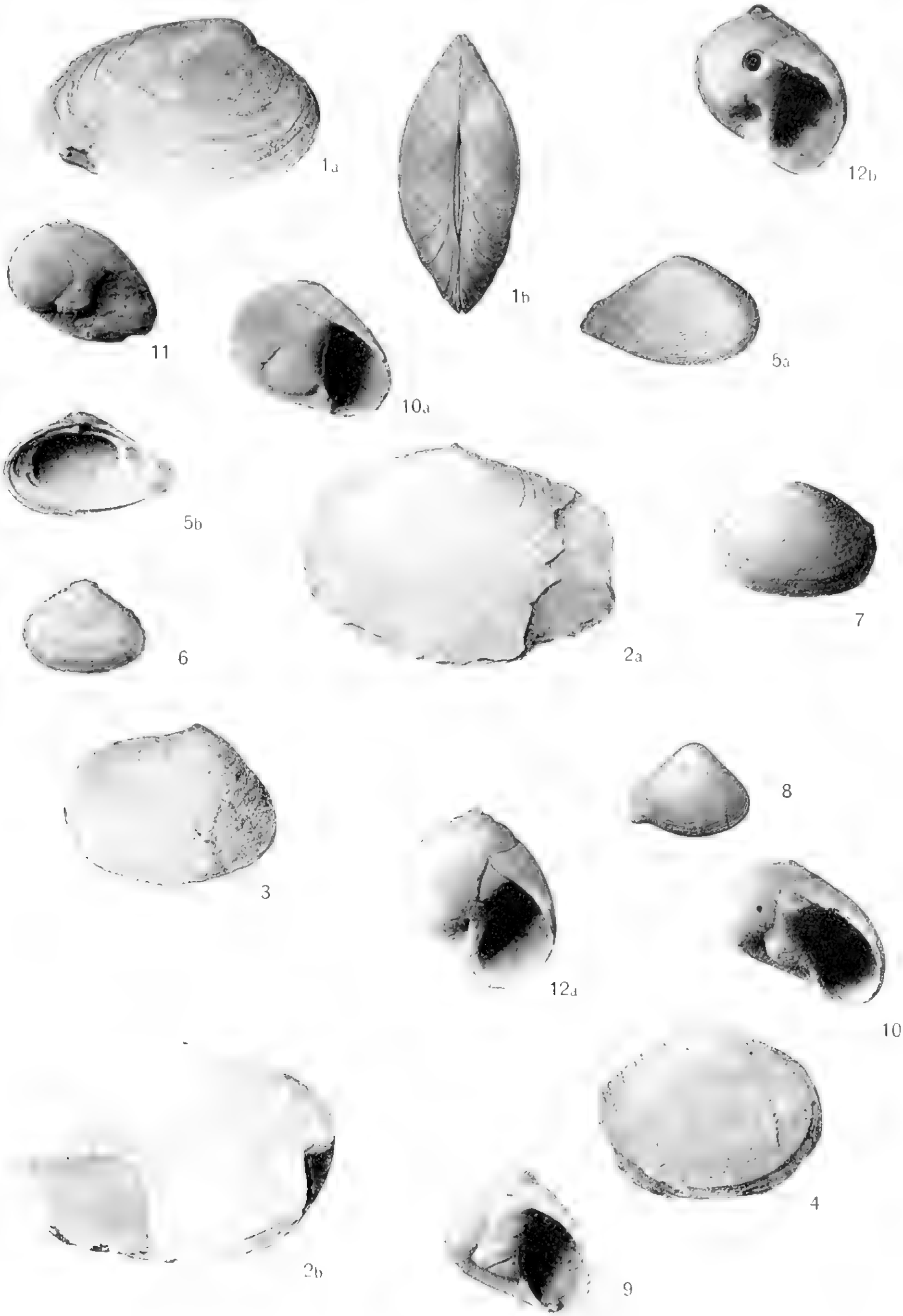
Fig. 10a. Neverita weaveri, new species, ×2. Type.

Fig. 10b. Neverita weaveri, new species, ×3. Cotype showing young form with small umbilicus.

Fig. 11. Lunatia hornii Gabb, ×1. Specimen from Cal. Acad. Sci. Locality 245.

Fig. 12a. Lunatia cowlitzensis, new species, ×1. Type.

Fig. 12b. Lunatia cowlitzensis, new species, ×1. Cotype showing mouth view of broad variety.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12a
10b
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2b
9

EXPLANATION OF PLATE 5

Fig. 1a. Turritella uvasana Conrad, ×2. Mouth view of a beautiful specimen from Univ. of California Locality 672.

Fig. 1b. Turritella uvasana Conrad. ×1. Cal. Acad. Sci. Locality 244.

Fig. 1c. Turritella uvasana Conrad, ×1. Back view showing variation in strength of spire ribbing.

Fig. 2. Turritella uvasana bicarinata, new variety, ×1. View of type showing two well marked carinæ, Cal. Acad. Sci. Locality 244.

Fig. 3. Turritella uvasana Conrad, ×1. This specimen from Locality 244 appears to be intermediate between the specimen figured as Fig. 2a and specimen in Fig. 1c.

Fig. 4. Turritella uvasana tricarinata, new variety, ×1. Type.

Fig. 5a. Naticina obliqua Gabb, ×2. Cal. Acad. Sci. Locality 182.

Fig. 5b. Naticina obliqua Gabb, ×2. Mouth view of same specimen figured as Fig. 5a.

Fig. 6a. Crepidula, new species, ×2.

Fig. 6b. Crepidula, new species, ×2. Back view of same specimen, from Cal. Acad. Sci. Locality 182.

Fig. 7a. Nerita cowlitzensis, new species, ×2. Mouth view of type.

Fig. 7b. Nerita cowlitzensis, new species, ×2. Back view of type.

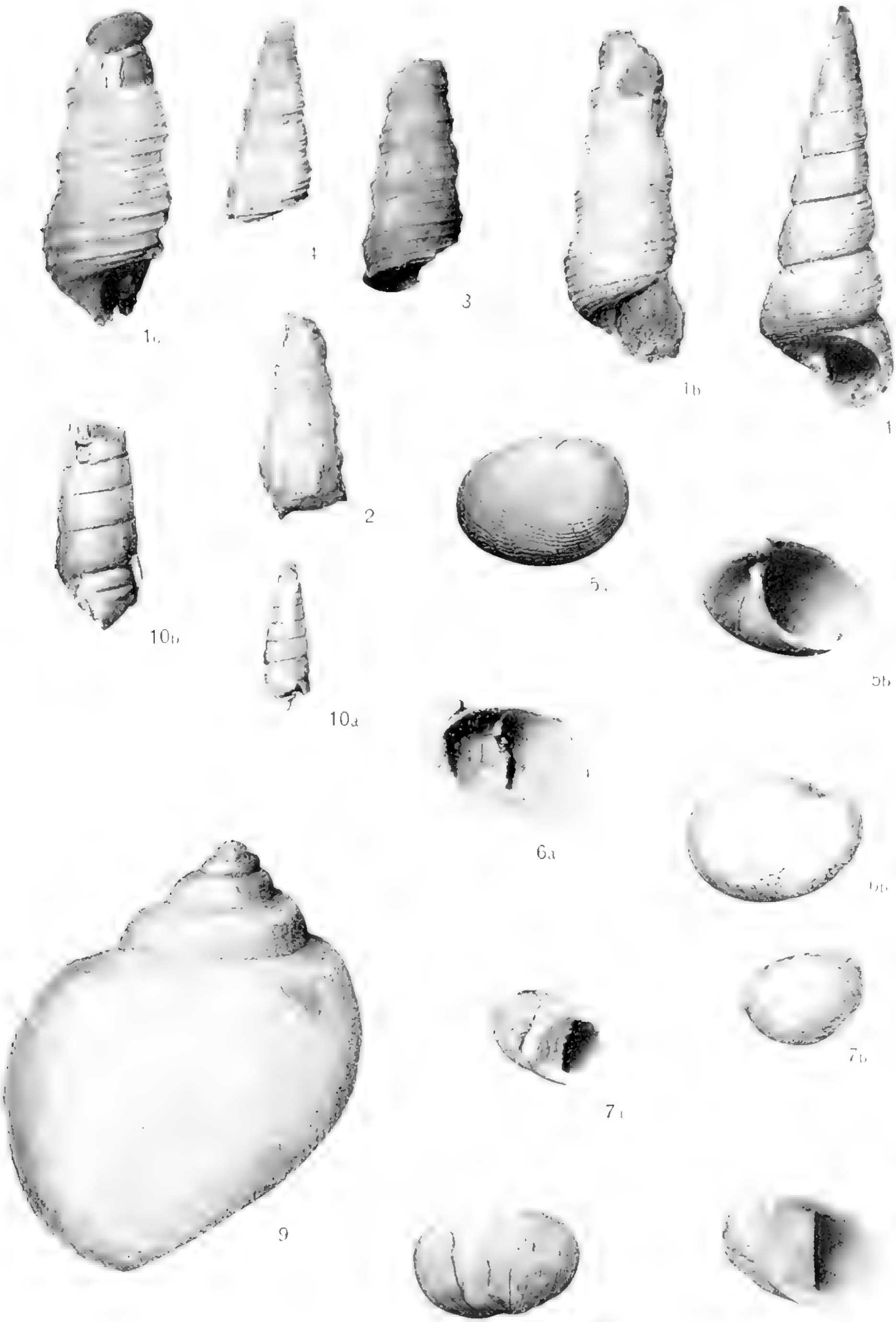
Fig. 8a. Neritina martini, new species, ×1. Type.

Fig. 8b. Neritina martini, new species, ×1. Back view of type.

Fig. 9. Amauropsis alveata (Conrad), ×1. Back view of an unusually large specimen of this characteristic Tejon species.

Fig. 10a. Odostomia, new species, ×3. Specimen from Cal. Acad. Sci. Locality 183.

Fig. 10b. Odostomia, new species, ×3. View of a larger specimen.


1c
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1b
1a
10b
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5a
5b
10a
6a
6b
9
7a
7b

EXPLANATION OF PLATE 6

Fig. 1a. Rimella simplex Gabb, ×1. Cal. Acad. Sci. Locality 182.

Fig. 1b. Rimella simplex Gabb, ×1. Mouth view.

Fig. 2. Rimella elongata (Weaver), ×2.

Fig. 3a. Galeodea tuberculata (Gabb), ×1. Mouth view of specimen from Cal. Acad. Sci. Locality 182.

Fig. 3b. Galeodea tuberculata (Gabb), ×1. Back view of same specimen.

Fig. 4a. Cypræa bayerquei Gabb, ×2. Side view of specimen from Univ. of Cal. Locality 452.

Fig. 4b. Cypræa bayerquei, ×2. Back view of specimen from Univ. of Cal. Locality 452.

Fig. 5. Cypræa mathewsonii Gabb, ×2. Mouth view of specimen from Cal. Acad. Sci. Locality 245.

Fig. 6. Melania packardi, new species, ×2. Type.

Fig. 7. Melania vaderensis, new species, ×2. Type.

Fig. 8. Ficopsis remondii Gabb, ×2. This species is very close to *Pyrula penita* Conrad of the Claiborne Eocene. Specimen figured is from Cal. Acad Sci. Locality 244.

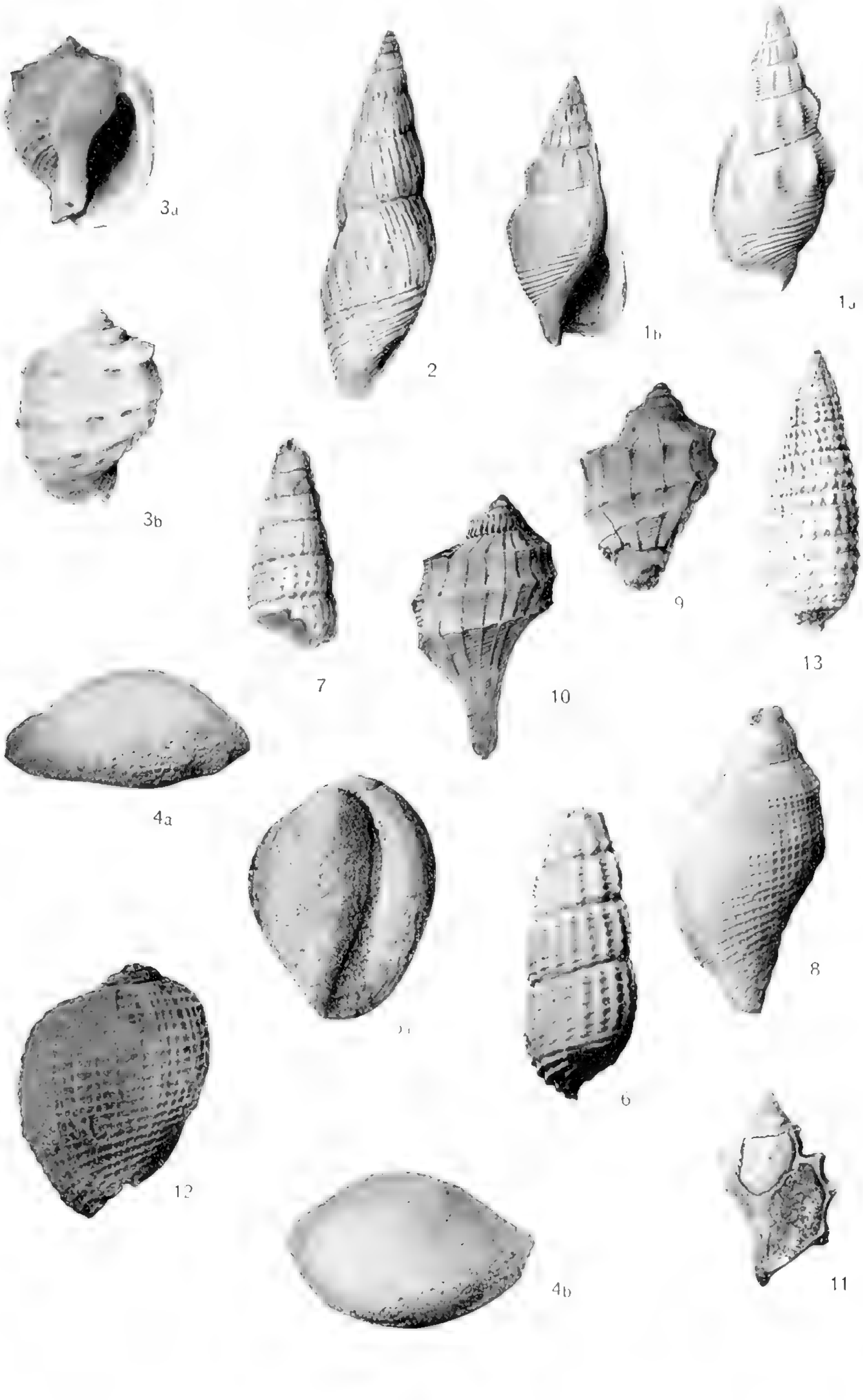
Fig. 9. Ficopsis hornii Gabb, ×1. Cal. Acad. Sci. Locality 244.

Fig. 10. Ficopsis cowlitzensis (Weaver), ×1. The cotype figured is from Cal. Acad. Sci. Locality 182. This form is very near *F. hornii* Gabb as will be seen upon comparing figures.

Fig. 11. Ficopsis cooperi Gabb, ×1. Cotype from Rose Canyon, San Diego County, Cal.

Fig. 12. Ficus mamillatus Gabb, ×2. This specimen from Cal. Acad. Sci. Locality 244 was placed by Conrad in the genus *Ficopsis*.

Fig. 13. Triforis washingtoniana, new species, ×3.


3a
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1b
1a
3b
9
13
7
10
4a
8
6
12
11
4b

EXPLANATION OF PLATE 7

Fig. 1a. Pseudoliva inornata, new species, ×1. Type from Univ. of Cal. Locality 458.

Fig. 1b. Pseudoliva inornata, new species, ×2. Cal. Acad. Sci. Locality 183.

Fig. 1c. Pseudoliva inornata, new species, ×2. Mouth view of specimen figured as Fig. 1a.

Fig. 2. Pseudoliva tejonensis, new species, ×1. Type from Cal. Acad. Sci. Locality 245.

Fig. 3a. Pseudoliva volutæformis Gabb, ×1. This is a mature specimen from Cal. Acad. Sci. Locality 244.

Fig. 3b. Pseudoliva volutæformis Gabb, ×2. This specimen is a young individual from Cal. Acad. Sci. Locality 244.

Fig. 4. Bursa washingtoniana (Weaver), ×1.

Fig. 5a. Nyctilochus kewi, new species, ×1. Mouth view of type.

Fig. 5b. Nyctilochus kewi, new species, ×1. Back view of type.

Fig 6. Bursa washingtoniana (Weaver), ×1. Cotype from Cal. Acad. Sci. Locality 182.

Fig. 7. Nyctilochus californicus Gabb, ×1. The specimen figured is far larger than Gabb's type. Univ. of Cal. Locality 458.

Fig. 8. Nyctilochus hornii (Gabb), ×2. Cal. Acad. Sci. Locality 244.

Fig. 9. Nyctilochus washingtoniana (Weaver), ×1. This specimen was described as *Cassidaria washingtoniana*, the canal being absent from the type specimen. Cotype from Cal. Acad. Sci. Locality 182.

Fig. 10a. Cantharus perrini, new species, ×2. Mouth view of type.

Fig. 10b. Cantharus perrini, new species, ×2. Back view of type.

Fig. 11. Chrysodomus ruckmani, new species, ×1. Aperture view of type. Univ. of Cal. Locality 452.


1a
4
10a
10b
3a
2
7
6
3b
1b
11
8

EXPLANATION OF PLATE 8

Fig. 1a. Siphonalia bicarinata, new species, ×2. Type.

Fig. 1b. Siphonalia bicarinata, new species, ×2. Aperture view of type.

Fig. 1c. Siphonalia bicarinata, new species, ×2. Back view of young individual, a cotype.

Fig. 1d. Siphonalia bicarinata, new species, ×2. Aperture view of specimen figured at Fig. 1c.

Fig. 2a. Hemifusus sopenahensis Weaver, ×1. Cotype.

Fig. 2b. Hemifusus sopenahensis Weaver, ×1. Cotype. This specimen, a young individual, suggests the genus *Nystilochus* decidedly. It differs in certain details of form from mature specimens.

Fig. 3a. Molopophorus tejonensis, new species, ×2. Aperture view of type.

Fig. 3b. Molopophorus tejonensis, new species, ×2. Back view of type.

Fig. 4a. Hemifusus volutæformis, new species, ×2. Aperture view of type.

Fig. 4b. Hemifusus volutæformis, new species, ×2. Back view of type.

Fig. 5a. Urosalpinx tejonensis (Weaver), ×2. Cotype from Cal. Acad. Sci. Locality 182. This was described by Weaver as *Hemifusus tejonensis* but better material shows it to belong in the genus *Urosalpinx*.

Fig. 5b. Urosalpinx tejonensis (Weaver), ×2. Aperture view of cotype.

Fig. 5c. Urosalpinx tejonensis (Weaver), ×2. Aperture view of a short variety.

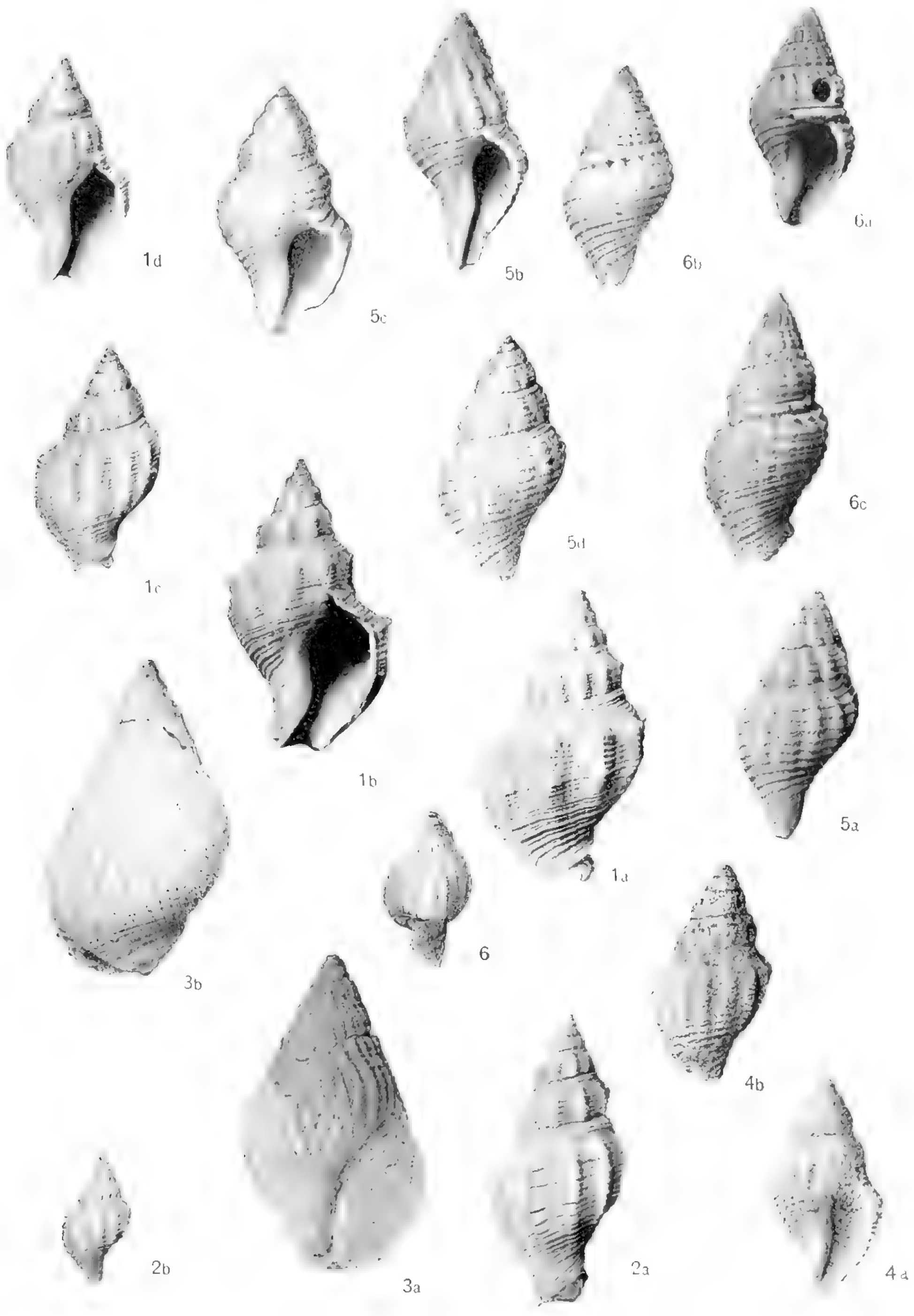
Fig. 5d. Urosalpinx tejonensis (Weaver), ×2. Back view of specimen figured as 5c.

Fig. 6a. Amphissa eocenica (Weaver), ×2. Cotype.

Fig. 6b. Amphissa eocenica (Weaver), ×2.

Fig. 6c. Amphissa eocenica (Weaver), ×2. Cotype illustrating change in proportions in older individuals.

Fig. 7. Molopophorus striata Gabb, ×3.


1d
5c
5b
6b
6a
1c
1b
5d
6c
1a
5a
3b
6
4b
2b
3a
2a
4a

EXPLANATION OF PLATE 9

Fig. 1. Exilia diaboli (Gabb), ×2. University of Cal. Locality 452.

Fig. 2a. Exilia perkinsiana (Cooper), ×2. Back view of species from Cal. Acad. Sci. Locality 183.

Fig. 2b. Exilia perkinsiana (Cooper), ×2. View showing canal and body whorl of a specimen from Cal. Acad. Sci. Locality 183.

Fig. 3. Exilia waringi, new species, ×3. Type. Cal. Acad. Sci. Locality 244.

Fig. 4. Nyctilochus cowlitzensis (Weaver), ×1. Cotype. Cal. Acad. Sci. Locality 182.

Fig. 5a. Whitneya ficus Gabb, ×2. Back view of a young individual showing strong axial ribs.

Fig. 5b. Whitneya ficus Gabb, ×2. Mouth view of second member of a series illustrating the axial ribs in the vicinity of the inner lip. The rest of the body whorl is smooth.

Fig. 5c. Whitneya ficus Gabb, ×1. View showing a mature individual. This series showing stages of growth was collected at Cal. Acad. Sci. Locality 245.

Fig. 5d. Whitneya ficus Gabb, ×1.

Fig. 6a. Murex packardi, new species, ×1. Aperture view of type.

Fig. 6b. Murex packardi, new species, ×1. Back view of type.

Fig. 7a. Urosalpinx hannibali, new species, ×2. Aperture view of type.

Fig 7b. Urosalpinx hannibali, new species, ×2. Back view of type.

Fig. 8. Fusus washingtoniana Weaver, ×1.

Fig. 9. Exilia dickersoni (Weaver), ×1.


5d
5c
6a
7a
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6b
7b
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2a

EXPLANATION OF PLATE 10

Fig. 1. Surcula cohni, new species, ×2. Type.

Fig. 2a. Surcula (Surculites) sinuata Gabb, ×1. Mouth view of half grown individual which is marked by spiral lines. Univ. of Cal. Locality 458.

Fig. 2b. Surcula (Surculites) sinuata Gabb, ×1. Back view of specimen figured as Fig. 2a.

Fig. 2c. Surcula (Surculites) sinuata Gabb, ×1. Back view of mature individual showing almost complete absence of decoration. Univ. of Cal. Locality 458.

Fig. 3. Drillia ornata, new species, ×2. Type specimen.

Fig. 4a. Turris pulchra, new species, ×2. Mouth view of type specimen.

Fig. 4b. Turris pulchra, new species, ×2. Back view of type.

Fig. 5. Turris, new species, ×2.

Fig. 6. Turris monolifera Cooper, new species, ×2. Specimen is an unusually large one from Cal. Acad. Sci. Locality 183.

Fig. 7a. Surcula washingtoniana (Weaver), ×1. Mouth view of cotype.

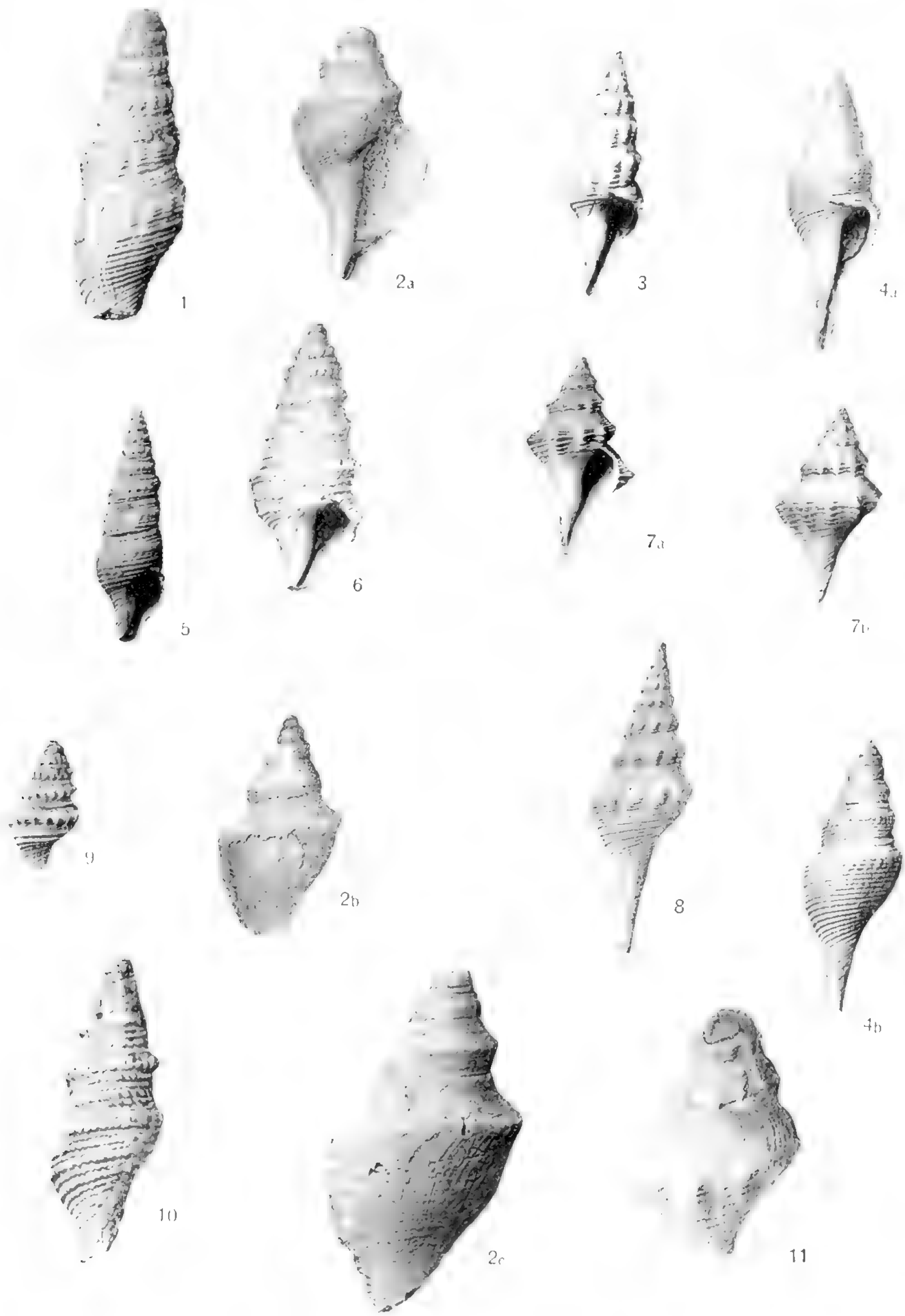
Fig. 7b. Surcula washingtoniana (Weaver), ×1. Back view of cotype.

Fig. 8. Surcula cowlitzensis Weaver, ×1. Back view of cotype from Cal. Acad. Sci. Locality 182. This is one of the most beautiful forms from the Tejon Eocene. It is abundant in Washington and at the type locality of the Tejon.

Fig. 9. Turris cf. monolifera Cooper, ×2. Specimen from Cal. Acad. Sci. Locality 183, a young individual.

Fig. 10. Surcula uvasana, new species. Back view of type.

Fig. 11. Surcula io (Gabb), ×1. This form was described as a *Fasciolaria* but careful examination fails to reveal any traces of plications and the position of the sinus is such as found in the genus *Surcula*. Cal. Acad. Sci. Locality 244.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2c
11

EXPLANATION OF PLATE 11

Fig. 1a. Fusus willisi, new species, ×2. Back view of type.

Fig. 1b. Fusus willisi, new species, ×2. Mouth view of type.

Fig. 2a. Fasciolaria buwaldana, new species, ×2. Back view of type.

Fig. 2b. Fasciolaria buwaldana, new species, ×2. Aperture view of type.

Fig. 3a. Fasciolaria sinuata Gabb, ×1. Back view of cotype from Cal. Acad. Sci. Locality 245. The characteristic lirations in this species can only be discerned as a rule by breaking a specimen so that the spire portion of the columella can be examined.

Fig. 3b. Fasciolaria sinuata Gabb, ×1.

Fig. 4. Perissolax blakei (Conrad), ×1. Cotype from Cal. Acad. Sci. Locality 244.

Fig. 5. Actæon, new species, ×3. Cal. Acad. Sci. Locality 244.

Fig. 6. Conus californiana (Conrad), ×1. Univ. of Cal. Locality 456.

Fig. 7. Conus remondii Gabb, ×1. Cal. Acad. Sci. Locality 182.

Fig. 8. Conus cowlitzensis Weaver, ×1. Cotype from Cal. Acad. Sci. Locality 182.

Fig. 9a. Conus hornii Gabb, ×1. Cotype from Cal. Acad. Sci. Locality 244.

Fig. 9b. Conus hornii Gabb, ×1.

Fig. 9c. Conus hornii Gabb, ×1.

Fig. 10. Conus weaveri, new species, ×2. Type.

Fig. 11a. Mitra washingtoniana Weaver, ×1. Cotype.

Fig. 11b. Mitra washingtoniana Weaver, ×1. Mouth view.

Fig. 12. Mitra simplicissima Cooper, ×2. Cotype from Univ. of Cal. Locality 2226, Rose Canyon.

Fig. 13a. Mitra uvasana, new species, ×1. Type from Cal. Acad. Sci. Locality 244.

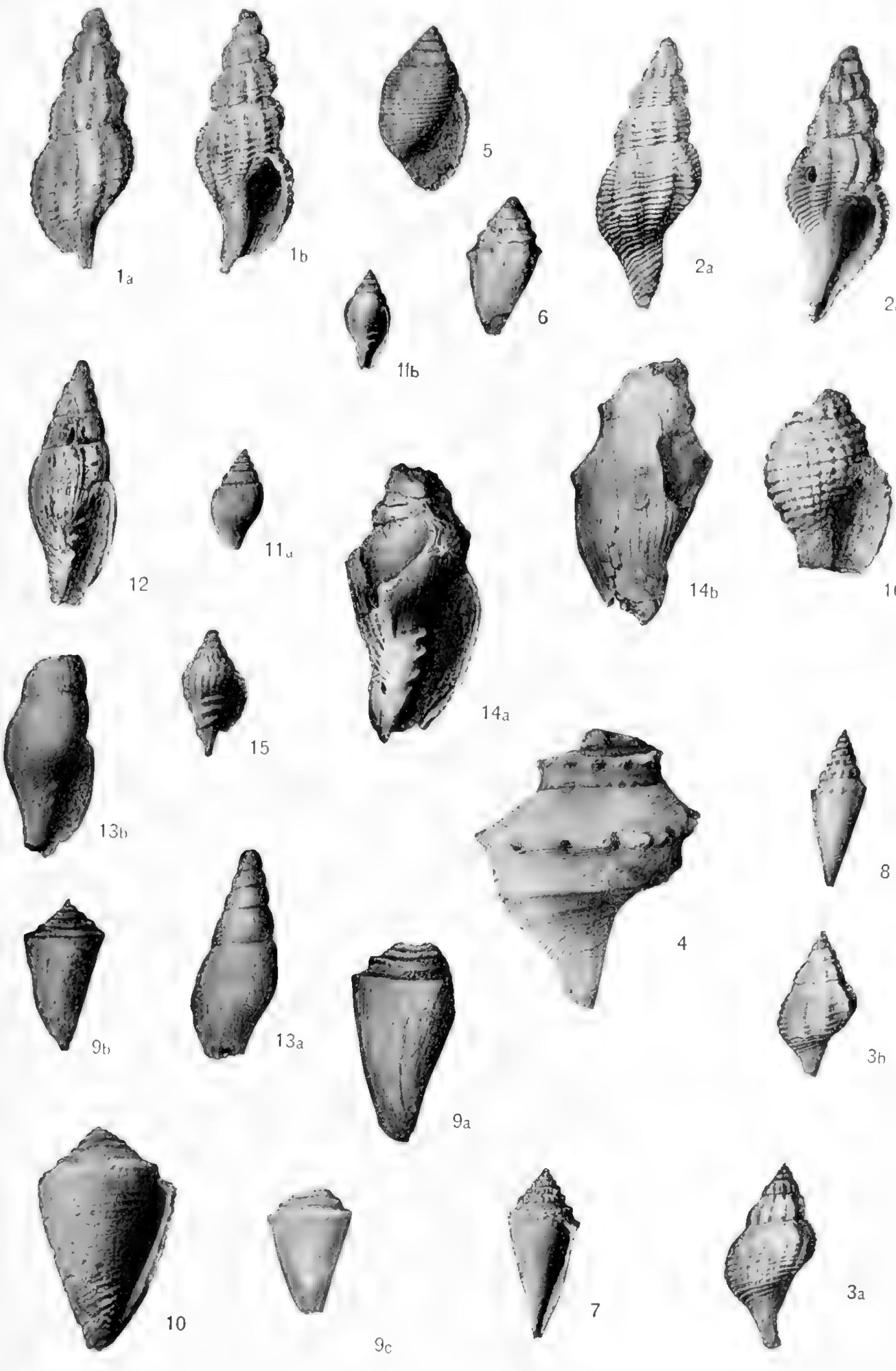
Fig. 13b. Mitra uvasana, new species, ×1. Cotype. View showing aperture.

Fig. 14a. Voluta martini, new species, ×1. Type.

Fig. 14b. Voluta martini, new species, ×1. Back view of type.

Fig. 15. Voluta, sp. a, ×3. Cal. Acad. Sci. Locality 244.

Fig. 16. Voluta slevini, new species, ×2. Type.


1a
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A LIST OF THE AMPHIBIANS AND REPTILES OF UTAH, WITH NOTES ON THE SPECIES IN THE COLLECTION OF THE ACADEMY.

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The reptiles and amphibians of Utah have been but little known. Stansbury's and Wheeler's Surveys, the report on the Death Valley Expedition, Yarrow's Catalogue, and a few notes by Cope, Dickerson, and Van Denburgh include about all that has been published on the subject. Some of the records, particularly those of Yarrow, are open to question. As in the List of Amphibians and Reptiles of Arizona, published in 1913, it has been our aim to exclude from this list all species not definitely known to live within the state. Where we have been in doubt as to the authenticity of a record the species has been omitted.

Our Utah collections are chiefly the result of the efforts of Mr. Slevin during the spring and summer of 1913, but a large number of specimens was secured for us by Chaplain Joseph Clemens, U. S. A., mainly in the vicinity of Fort Douglas. To him our thanks are due.

The following list includes 36 species. Those which the Academy has not yet secured from within the borders of Utah

are indicated by a star preceding the number. Following this list are given notes on the species represented in the Academy's collections.

List of the Amphibians and Reptiles of Utah.

1. Ambystoma tigrinum
*2. Hyla arenicolor
3. Chorophilus nigritus triseriatus
4. Bufo boreas
5. Bufo lentiginosus woodhousii
*6. Bufo punctatus
7. Scaphiopus hammondii
8. Rana pipiens
9. Rana pretiosa
*10. Rana onca
*11. Sauromalus ater
12. Crotaphytus collaris baileyi
13. Crotaphytus wislizenii
*14. Callisaurus ventralis
15. Uta stansburiana
16. Uta ornata
17. Sceloporus graciosus
18. Sceloporus elongatus
*19. Sceloporus biseriatus
*20. Sceloporus consobrinus
*21. Sceloporus magister
22. Phrynosoma douglassii
23. Phrynosoma platyrhinos
24. Cnemidophorus tigris
25. Eumeces skiltonianus
26. Charina bottæ
*27. Sonora semiannulata
*28. Salvadora grahamiæ
29. Hypsiglena ochrorhynchus
30. Bascanion constrictor vetustum
*31. Bascanion flagellum frenatum
32. Bascanion tæniatum
33. Pituophis catenifer deserticola
34. Thamnophis parietalis
35. Thamnophis vagrans
36. Crotalus oregonus

1.—**Ambystoma tigrinum** (Green).

No adult salamanders were found but the collections include 32 larval or recently transformed specimens. Eighteen (Nos. 27205, and 30938 to 30954) were sent to us from Fort Douglas, Salt Lake County. The other 14 (Nos. 38664 to 38676) were collected by Mr. Slevin at Lake Solitude, Wasatch County, July 3 to 5, 1913. Lake Solitude is at an altitude of about 9000 feet and snow still lay on the ground at this date. The specimens were found under moss and leaves in the water near shore. They have no gills, but do not show any yellow markings. Smaller larvæ three or four inches long, with gills, were also found in the lake at this time. No adults or eggs were seen. In these Lake Solitude salamanders the costal folds vary in number from 12 to 15, being 12 twice, 13 eighteen times, 14 seven times, and 15 once. There is only one specimen which has not 13 grooves on at least one side of the body.

3.—**Chorophilus nigritus triseriatus** (Wied).

A single adult (No. 38677) was found in Provo Canyon, Wasatch Mountains, Wasatch County, May 19 to 26, 1913. It was caught in a little marshy meadow beside the Provo River.

4.—**Bufo boreas** Baird & Girard.

Our collections include 87 Utah specimens of this toad. Of these, 37 (Nos. 14375 to 14407, 27289, 27291, 27294 and 27296) were collected near Fort Douglas, Salt Lake County; four (Nos. 14411 to 14414) were taken at Kimballs, near Park City, Summit County; No. 38636 was found in Little Cottonwood Canyon, Wasatch Mts., Wasatch County, June 28-29, 1913; twenty-four (Nos. 38639 to 38662) were secured at an altitude of 8728 feet at the head of Big Cottonwood Canyon, Wasatch Mountains, Wasatch County, July 3-5, 1913; and twenty-one were collected in Provo Canyon, Wasatch Mts., Wasatch County, May 19 to June 20, 1913.

5.—**Bufo lentiginosus woodhousii** (Girard).

One hundred and seventy-seven of these toads are at hand from Utah. One hundred and forty-seven of these were col-

lected near Fort Douglas, Salt Lake County (Nos. 14221 to 14334, 14337 to 14349, 14351 to 14355, 14358 to 14361, 27287, 27288, 27290, 27292, 27293, 27295, and 27297 to 27301); twenty (Nos. 38401 to 38420) were secured at Provo, Utah County, June 20, 1913; nos. 38637 and 38638 were caught June 28-29, 1913, in Little Cottonwood Canyon, Wasatch Mountains, Wasatch County; and seven (Nos. 38395 to 38400) were obtained at Green River, Emery County, June 5-7, 1913.

7.—**Scaphiopus hammondii** Baird.

We have received three spade-foot toads (Nos. 14335, 14336, and 27206) from Fort Douglas, Salt Lake County, where they were collected in June and July, 1908, and on May 15, 1909.

8.—**Rana pipiens** Schreber.

Our Utah collections include 104 frogs of this species. Five specimens (Nos. 38389 to 38393) are from Green River, Emery County, June 5 and 6, 1913; forty-five (Nos. 38526 to 38570) were collected in Provo Canyon, Wasatch Mountains, Wasatch County, May 19 to June 13, 1913; fifty-three (Nos. 14115, 14416 to 14462, and 30933 to 30937) were secured near Fort Douglas, Salt Lake County; and No. 14463 was taken at Kimberly, Piute County. These frogs seem not to differ from those in our series from Arizona.

9.—**Rana pretiosa** Baird & Girard.

We have 45 of these frogs from Utah. One (No. 14492) was secured near Fort Douglas, Salt Lake County, and the others (Nos. 38571 to 38614) were collected in Provo Canyon, Wasatch Mountains, Wasatch County, May 19 to June 13, 1913. We are unable to distinguish these frogs from others collected at Klamath Falls, Oregon, and Mt. Rainier, Washington. There appears to be no constant difference in coloration or in plantar or palmar tubercles.

12.—**Crotaphytus collaris baileyi** (Stejneger).

We have 16 of these lizards from Utah. Nine (Nos. 38208 to 38216) are from Thompson, Grand County, May 30 to

June 4, 1913; and seven (Nos. 38032 to 38038) were secured at Newhouse, Beaver County, May 15, 1913. Those from Thompson are much greener than the Newhouse specimens. The central head scales are in two series in all these Utah specimens.

The femoral pores in these specimens vary from 15 to 20; being 15 three times, 16 four times, 17 seven times, 18 eight times, 19 six times, and 20 four times.

13.—**Crotaphytus wislizenii** Baird & Girard.

Twenty-two were secured in Utah. Of these, 18 (Nos. 38217 to 38234) were shot near Thompson, Grand County, May 30 to June 4, 1913; two (Nos. 38343 to 38344) at Elgin, in the same county, June 5 to 7, 1913; one (No. 38376) at Green River, Emery County, June 6, 1913; and one (No. 38031) near Newhouse, Beaver County, May 15, 1913.

Femoral pores in these specimens vary from 17 to 24; being 17 twice, 19 three times, 20 seven times, 21 fourteen times, 22 eight times, 23 nine times, and 24 once.

15.—**Uta stansburiana** Baird & Girard.

Fifty specimens from Utah are at hand, as follows: Twenty-nine (Nos. 38047 to 38075) from Newhouse, Beaver County, May 15, 1913; three (Nos. 38386 to 38388) from Green River, Emery County, June 5-7, 1913; two (Nos. 38345, 38346) from Elgin, Grand County, June 5, 1913; and 16 Nos. 38326 to 38341) from Thompson, Grand County, May 30 to June 4, 1913.

The femoral pores in 15 specimens from Emery and Grand counties vary from 13 to 16; being 13 twice, 14 ten times, 15 fourteen times, and 16 four times. In 24 lizards from Newhouse the pores vary from 12 to 16; being 12 once, 13 nine times, 14 twenty times, 15 fifteen times, and 16 three times.

16.—**Uta ornata** Baird & Girard.

This lizard was found at Thompson, Grand County, where 22 specimens (Nos. 38304 to 38325) were collected May 30 to June 4, 1913. Utah specimens seem not to differ from those taken in Arizona. Femoral pores in 17 specimens vary from 12 to 16; being 12 five times, 13 fifteen times, 14 eleven times, 15 twice, and 16 once.

17.—**Sceloporus graciosus** Baird & Girard.

We have 94 specimens from Utah. There are four (Nos. 38300 to 38303) from Thompson, Grand County, May 30 to June 4, 1913; 29 (Nos. 38497 to 38525) from the Wasatch Mountains, Wasatch County, May 19 to June 20, 1913; 44 (Nos. 14159 to 14162, 27159 to 27195, and 30927 to 30929) from Fort Douglas, near Salt Lake City, Salt Lake County; eight (Nos. 38085 to 38092) from Beaver, Beaver County, May 13, 1913; and nine (Nos. 38076 to 38084) from Milford, Beaver County, May 16, 1913.

Femoral pores in 90 specimens vary from 9 to 16; being 9 once, 11 twelve times, 12 fifty-three times, 13 sixty-nine times, 14 twenty-five times, 15 seventeen times, and 16 three times.

18.—**Sceloporus elongatus** Stejneger.

We refer to this species 65 specimens (Nos. 38235 to 38299) collected at Thompson, Grand County, May 30 to June 4, 1913. Femoral pores in 64 of these vary from 16 to 22; being 16 eight times, 17 eighteen times, 18 thirty-four times, 19 thirty times, 20 twenty-four times, 21 ten times, and 22 four times. The dorsal scales in a row from the interparietal plate to a line joining the backs of the thighs in 45 of these lizards vary from 44 to 50; being 44 four times, 45 five times, 46 nine times, 47 ten times, 48 eight times, 49 once, and 50 eight times.

Dr. Stejneger, at our request, has very kindly compared three of these specimens with the original specimens of *S. elongatus,* and writes that he finds them identical. It is interesting to find in Utah this species which has been known only from the original Arizonan specimens. This species differs from *S. biseriatus* in general coloration, in having two blue spots on the throat (as in *S. occidentalis* and *S. consobrinus*) and in its smaller dorsal scales. We are not certain that Utah records of *S. consobrinus* may not be based, at least in part, on this species, although the coloration is quite different. *S. smaragdinus* was originally described from specimens from Utah and Nevada, but its 14 femoral pores, 41 scales from head to base of tail, and entire middle portion of throat blackish blue, indicate that it was based upon specimens of *S. biseriatus.*

22.—**Phrynosoma douglassii** (Bell).

The collection includes 18 of these horned toads. One (No. 38342) was caught near Thompson, Grand County, May 30 to June 4, 1913; sixteen (Nos. 14153 to 14158, 14493 to 14494, 27156 to 27158, and 30930 to 30932, 38763, 38764) were collected in the vicinity of Fort Douglas, Salt Lake County; and one (No. 38093) was taken near Beaver, Beaver County, May 13, 1913.

Femoral pores in 16 specimens vary from 13 to 17; being 13 four times, 14 eight times, 15 twelve times, 16 six times, 17 twice. This form differs from *Phrynosoma hernandesi* principally in its shorter cephalic horns and larger scales on the belly.

23.—**Phrynosoma platyrhinos** Girard.

We have only one specimen (No. 38039) caught at Newhouse, Beaver County, May 15, 1913. Its femoral pores are 9-9.

24.—**Cnemidophorus tigris** Baird & Girard.

One hundred and twenty-seven Utah specimens are in our collections. One hundred and eight (Nos. 38099 to 38207) were shot at Thompson, Grand County, May 30 to June 4, 1913; nine (Nos. 38377 to 38385) were collected at Green River, Emery County, June 5, 6, 1913; three (Nos. 14163, 14496, 14497) were secured near Fort Douglas, Salt Lake County; and seven (Nos. 38040 to 38046) were taken at Newhouse, Beaver County, May 15, 1913.

The femoral pores in 124 of these specimens vary from 17 to 23; being 17 three times, 18 seventeen times, 19 forty-five times, 20 fifty-seven times, 21 sixty-one times, 22 fifty times, and 23 fifteen times. The average number of pores on the 248 thighs is 20.47, as against 20.64 on 160 thighs of specimens from Yuma, Arizona.

25.—**Eumeces skiltonianus** (Baird & Girard).

Four skinks of this species (Nos. 38094 to 38097) were caught under stones in the oak belt of the foothills near Mt. Baldy, Beaver County, May 13, 1913. They seem to be typical in coloration and scale characters. The scales around the mid-

dle of the body are 26, 24, 26, 24, and in a row from the back of the head to a line joining the backs of the thighs one counts 56, 56, 57, 57 scales.

We believe this skink has not before been recorded east of California. Yarrow mentions *Eumeces obsoletus* as having been taken in Utah, but his records are open to question until confirmed.

26.—**Charina bottæ** (Blainville).

We have seven of these boas from Utah. No. 38421 was found in Little Cottonwood Canyon, Wasatch Mts., Wasatch County, June 28, 1913; four (Nos. 38422 to 38425) were secured in Provo Canyon, in the Wasatch Mountains, May 19 to June 20, 1913. The other two (Nos. 27197 and 38762) were collected near Fort Douglas, Salt Lake County. This species seems not to have been taken previously east of Nevada. Variation in scale-counts is shown in the following table:

No.	Sex	Scale rows	Gastro-steges	Uro-steges	Supra-labials	Infra-labials	Loreals
27197	♂	41	208	39	......	......	...
38421	♀	41	205	33	10—10	13—11	1—1
38422	♀	41	207	33	10—10	10—10	1—1
38423	♂	41	206	35	9—9	10—10	1—1
38424	♀	41	204	34	9—10	11—11	1—1
38425	♀	41	210	35	9—9	11—11	1—1
38762	♂	41	202	..	9—9	11—11	1—1

29.—**Hypsiglena ochrorhynchus** Cope.

We have two snakes of this kind (Nos. 30925 and 30926) collected near Fort Douglas, Salt Lake County, in 1910.

No. 30925, a female, has 21 scale-rows, gastrosteges 182, urosteges 49, anal divided, supralabials 8–8, infralabials 10–10, preoculars 1–1, postoculars 2–2, temporals 1+2–1+2, loreal 1–1, posterior genials shorter.

No. 30926, a male, has 21 scale-rows, gastrosteges 177, urosteges 50, anal divided, supralabials 7–7, infralabials 9–9, preoculars 1–1, postoculars 2–2, temporals 1+1–1+2, loreal 1–1, posterior genials shorter.

We do not know of any previous record of this snake for Utah.

30.—Bascanion constrictor vetustum (Baird & Girard).

This snake evidently is common in Utah. We have secured 30 specimens. Thirteen of these (Nos. 38426 to 38438) are from Provo Canyon, Wasatch Mountains, Wasatch County, May 19, to June 20, 1913. The other 17 are from Fort Douglas, Salt Lake County. Variation in scale characters is shown in the following table:

No.	Sex	Scale rows	Gastro-steges	Uro-steges	Supra-labials	Infra-labials	Pre-oculars	Post-oculars	Loreals	Temporals
38426	♂	17	171	90	7—7	8—8	2—2	2—2	1—1	2+2—2+2
38427	♀	17	164	83	7—8	8—8	2—2	2—2	1—1	2+2—2+2
38428	♀	17	170	82	8—8	9—8	2—2	2—2	1—1	2+2—2+2
38429	♀	17	176	85	7—8	8—7	2—2	2—2	1—1	2+2—2+2
38430	♂	17	164	94	8—8	9—8	2—2	2—2	1—1	2+2—2+2
38431	♂	17	167	90	7—7	8—8	2—2	2—2	1—1	2+2—2+2
38432	♀	17	172	91	8—8	9—9	2—2	2—2	1—1	2+2—2+2
38433	♂	17	168	90	7—7	8—8	2—2	2—2	1—1	2+2—2+2
38434	♂	17	170	97	7—8	8—8	2—2	2—2	1—1	2+2—2+2
38435	♂	17	165	86	7—8	8—8	2—2	2—2	1—1	2+2—2+2
38436	♀	17	172	..	7—8	8—8	2—2	2—2	1—1	2+2—2+2
38437	♀	17	171	86	8—8	8—8	2—2	2—2	1—1	2+2—2+2
38438	♂	17	164	89	7—7	8—7	2—2	2—2	1—1	2+2—2+2
14164	♂	17	172	..	8—7	8—8	2—2	2—2	1—1	2+2—2+2
14165	♀	17	...	82	....	....	....	....	....	....
14168	♂	17	173	..	7—7	9—8	2—2	2—2	1—1	2+2—2+2
14170	♂	17	170	88	7—8	8—8	2—2	2—2	1—1	2+2—2+2
14171	♂	17	169	..	8—8	....	2—2	2—2	1—1	2+2—2+2
14172	♂	17	170	102	X—7	X—8	2—2	2—2	1—1	2+2—2+2
14173	♀	17	173	90	8—8	8—8	2—2	2—2	1—1	2+2—2+2
14174	♂	17	176	95	8—8	8—8	2—2	2—2	1—1	2+2—2+2
14175	♂	17	172	98	8—8	9—X	2—2	2—2	1—1	2+2—2+2
14176	♀	17	172	86	7—8	8—8	2—2	2—2	1—1	2+2—2+2
14177	♂	17	168	87	8—7	8—8	2—2	2—2	1—1	2+2—2+2
27200	♂	17	171	95	8—8	8—8	2—2	2—2	1—1	2+2—2+2
27201	♀	..	...	88	7—8	X—8	2—2	2—2	1—1	2+2—2+2
27202	♂	17	169	102	7—8	8—8	2—2	2—2	1—1	2+2—2+2
27203	♀	17	172	85	7—8	9—8	2—2	2—2	1—1	2+2—2+2
27204	♀	17	176	..	7—8	8—8	2—2	2—2	1—1	2+2—2+2
38760	♀	17	173	87	7—7	9—9	2—X	2—2	1—1	2+2—2+2

32.—Bascanion tæniatum (Hallowell).

Four specimens from Fort Douglas, Salt Lake County, have the following scale counts:

No.	Sex	Scale rows	Gastro-steges	Uro-steges	Supra-labials	Infra-labials	Pre-oculars	Post-oculars	Loreals	Temporals
14167	♂	15	202	140	8—8	X—X	2—2	2—2	1—1	2+2—2+2
30923	♀	15	202	131	8—8	X—9	2—2	2—2	1—1	2+2—2+2
30924	♀	15	204	...	8—8	8—7	2—2	2—2	1—1	2+2—2+2
38761	♀	15	209	127	8—8	9—9	2—2	2—2	1—1	2+2—2+2

33.—Pituophis catenifer deserticola Stejneger.

Twenty-eight of these snakes are at hand. No. 38755 was secured in Provo Canyon, Wasatch Mountains, Wasatch

County, June 26, 1913. The others are all from Fort Douglas, Salt Lake County. The following table gives the variation in scale characters:

No.	Sex	Scale rows	Gastro-steges	Uro-steges	Supra-labials	Infra-labials	Pre-oculars	Post-oculars	Loreals	Temporals
14193	♂	31	238	67	8—8	12—X	1—1	2—2	1—1	4+5—4+4
14194	♀	29	239	59	....	......	....	....	....	....
14195	♂	31	238	66	8—8	11—11	1—1	2—2	1—1	3+3—3+4
14196	♂	29	231	68	....	......	....	....	....	....
14197	♂	..	228	66	....	......	....	....	....	....
14198	♀	29	238	61	8—8	13—13	1—1	3—3	1—1	4+4—3+4
14199	♂	27	234	70	9—X	13—X	1—1	3—3	1—1	2+3—2+4
14200	♂	27	231	70	8—9	12—13	1—1	2—2	1—1	3+4
14201	♂	25	234	66	8—8	13—13	1—1	3—3	1—1	3+4—3+4
14202	♂	31	234	70	9—9	13—13	1—1	3—3	1—1	3+4—2+4
14203	♂	29	238	66	9—9	12—12	1—1	2—2	1—1	4+4—3+4
14204	♀	27	237	62	8—8	13—12	1—1	2—2	1—1	3+4—4+4
14205	♂	..	...	67	....	......	....	....	....	....
14206	♂	29	236	66	....	......	....	....	....	....
14207	♂	29	233	60	8—8	13—14	1—1	3—3	1—1	4+5—4+5
27198	♂	31	232	68	8—8	13—13	1—1	3—3	1—1	3+5—3+4
27199	♂	29	230	63	8—8	13—12	1—1	3—3	1—1	3+4—3+3
30913	♂	29	228	66	8—8	X—12	1—1	3—3	1—1	4+4—4+4
30914	♂	29	236	60	9—8	12—12	1—1	3—3	1—1	4+X—3+4
30915	♂	29	238	67	9—9	13—13	1—1	2—2	1—1	3+4—X+X
30916	♀	31	240	61	9—9	13—13	1—1	2—2	1—1	4+4—3+4
30917	♂	29	227	65	8—8	12—13	1—1	2—3	1—1	4+4—3+4
30918	♂	29	233	58	9—8	12—12	1—1	2—2	1—1	4+4—4+4
30919	♂	27	228	66	8—8	12—13	1—1	3—3	1—1	3+4—3+4
30920	♀	29	223	55	8—9	11—12	2—2	3—3	1—1	3+4—3+4
38755	♂	31	237	70	8—9	11—11	2—2	3—3	1—1	3+4—3+4
38756	♂	29	230	71	9—9	13—13	1—1	2—2	1—1	3+4—3+4
38757	♂	29	232	62	8—8	13—13	1—1	2—2	1—1	4+5—4+4

34.—**Thamnophis parietalis** (Say).

The only specimen of this snake in our collections from Utah is a female, No. 14169, secured near Fort Douglas, Salt Lake County, in June or July, 1908. Its scales are in 19 rows, gastrosteges 166, urosteges 75, supralabials 7–7, infralabials 10–10, preoculars 1–1, postoculars 3–3, loreal 1–1, temporals 2+3–1+2, posterior genials longer.

35.—**Thamnophis vagrans** (Baird & Girard).

This snake evidently is much more abundant in Utah than *Thamnophis parietalis.* We have 60 specimens. Nos. 14166, 38758 and 38759 were caught near Fort Douglas, Salt Lake County. All the others were collected in Provo Canyon, Wasatch Mountains, Wasatch County, May 19 to June 20, 1913. All show the typical coloration. Variation in scale characters is given in the following table:

No.	Sex	Scale rows	Gastro-steges	Uro-steges	Supra-labials	Infra-labials	Pre-oculars	Post-oculars	Loreals	Temporals
14166	♂	21	170	75	X—8	X—10	1—1	3—3	1—1	....
38758	♂	21	164	81	8—8	10—10	2—2	4—3	1—1	1+2+3—1+2+3
38759	♀	21	168	78	8—8	9—X	1—1	3—3	1—1	1+2+3—1+2+3
38440	♂	21	170	83	8—8	10—10	2—2	3—3	1—1	1+2+3—1+2+3
38441	♀	21	162	73	7—8	10—10	1—1	4—3	1—1	1+2+3—1+2+3
38442	♂	21	173	..	8—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38443	♀	21	160	..	8—8	10—10	2—2	4—4	1—1	1+2+3—1+2+3
38444	♀	21	163	75	8—8	10—10	1—1	4—4	1—1	1+2+3—1+2+3
38445	♂	21	174	93	8—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38446	♂	21	169	87	8—8	10—10	1—1	3—4	1—1	1+2+3—1+2+3
38447	♂	21	171	83	8—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38448	♂	21	169	65	8—8	10—10	1—1	3—4	1—1	1+2+3—1+2+3
38449	♀	21	161	70	8—8	10—10	1—1	3—4	1—1	1+2+3—1+2+3
38450	♂	21	172	90	8—8	10—10	1—1	3—4	1—1	1+2+3—1+2+3
38451	♀	21	166	76	8—9	11—11	1—1	3—3	1—1	1+2+3—1+2+3
38452	♀	21	162	71	8—8	10—10	2—2	3—3	1—1	1+3+4—1+2+3
38453	♀	21	163	74	8—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38454	♀	21	171	75	8—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38455	♀	21	167	75	8—8	10—10	1—1	3—3	1—1	1+2+3—1+3+3
38456	♀	21	162	70	8—8	11—10	1—1	3—3	1—1	1+2+3—1+2+3
38457	♀	21	166	73	8—8	10—9	1—1	3—3	1—1	1+2+3—1+2+3
38458	♂	21	168	..	8—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38459	♂	21	171	73	8—8	9—10	1—1	3—3	1—1	1+2+3—1+2+3
38460	♀	21	162	81	8—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38461	♂	21	159	85	8—8	10—X	1—1	3—3	1—1	1+2+3—1+2+3
38462	♀	21	165	78	8—8	10—10	1—1	3—4	1—1	1+2+3—1+2+3
38463	♂	21	172	86	8—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38464	♂	21	166	82	8—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38465	♂	21	169	91	8—8	10—10	1—1	4—3	1—1	1+2+3—1+2+3
38466	♂	21	167	86	8—8	10—10	1—1	3—3	1—1	1+2+4—1+2+3
38467	♂	21	173	88	7—8	10—9	1—1	3—3	1—1	1+2+3—1+2+3
38468	♂	21	171	..	8—8	10—11	1—1	3—3	1—1	1+2+3—1+2+3
38469	♂	21	169	77	8—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38470	♀	21	160	..	8—8	11—10	1—1	3—3	1—1	1+2+3—1+2+3
38471	♀	21	163	74	8—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38472	♀	21	173	75	8—7	9—9	2—2	4—4	1—1	1+2+3—1+2+3
38473	♂	21	167	..	8—8	10—10	1—1	4—3	1—1	1+2+4—1+2+3
38474	♂	21	170	84	8—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38475	♂	21	174	83	8—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38476	♂	21	173	80	8—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38477	♂	21	175	90	8—8	9—9	1—1	3—3	1—1	1+2+3—1+2+3
38478	♀	21	166	..	8—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38479	♂	21	173	87	8—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38480	♂	21	172	..	8—8	10—10	1—1	3—3	1—1	1+3+4—1+3+4
38481	♂	21	158	77	8—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38482	♂	21	172	82	8—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38483	♂	21	168	81	8—8	9—9	1—1	2—2	1—1	1+2+3—1+2+3
38484	♂	21	167	70	8—8	10—10	1—2	3—4	1—1	1+2+3—1+3+3
38485	♀	21	160	77	8—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38486	♀	21	166	77	7—8	9—10	1—1	3—3	1—1	1+2+3—1+2+3
38487	♀	21	164	78	8—8	10—9	1—1	3—3	1—1	1+2+3—1+2+3
38488	♀	21	172	78	8—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38489	♂	21	173	79	8—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38490	♂	21	168	82	8—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38491	♂	21	174	83	8—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38492	♂	21	172	85	7—8	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38493	♀	21	173	77	8—8	9—10	1—1	4—4	1—1	1+2+3—1+2+3
38494	♂	21	172	85	8—7	10—10	1—1	3—3	1—1	1+2+3—1+2+3
38495	♀	21	169	85	8—8	10—10	1—1	4—4	1—1	1+2+3—1+2+3
38496	♂	21	177	89	7—8	10—10	1—1	3—4	1—1	1+3+3—1+2+3

36.—**Crotalus oregonus** Holbrook.

Our collections include seven rattlesnakes from Utah. Six of these are typical *C. oregonus* in color and scale characters. The seventh (No. 38098) seems to agree with the others in squamation, but is creamy white in color without any darker markings. This last specimen was caught out on the sandy

desert south of Thompson, Grand County, May 30 to June 4, 1913. No. 38439 was secured in Provo Canyon, in the Wasatch Mountains, Wasatch County, May 19-26, 1913. The other five were collected near Fort Douglas, Salt Lake County.

No.	Sex	Scale rows	Gastro-steges	Uro-steges	Supra-labials	Infra-labials	Pre-oculars	Post-oculars	Loreals
14208	♂	25	178	..	16—X	16—X	2—X	....	1—X
14209	♂	27	180	..	14—14	15—X	X—2	....	....
27196	♂	25	171	24	15—16	15—16	2—2	3—3	1—1
30921	♀	25	179	20	15—15	15—15	2—2	3—3	1—1
30922	♂	25	179	24	15—17	17—17	2—2	3—3	....
38098	♂	25	178	22	15—16	15—16	2—2	3—3	....
38439	♂	25	175	18	16—15	16—14	2—2	3—3	1—1

Fig. 1. *Ambystoma tigrinum* (Green). Tiger Salamander. Young with gills. Lake Solitude, Wasatch County, Utah, July 3-5, 1913.

Fig. 2. *Sceloporus graciosus* Baird & Girard. Mountain Lizard. Provo Canyon, Wasatch County, Utah, May 23, 1913.

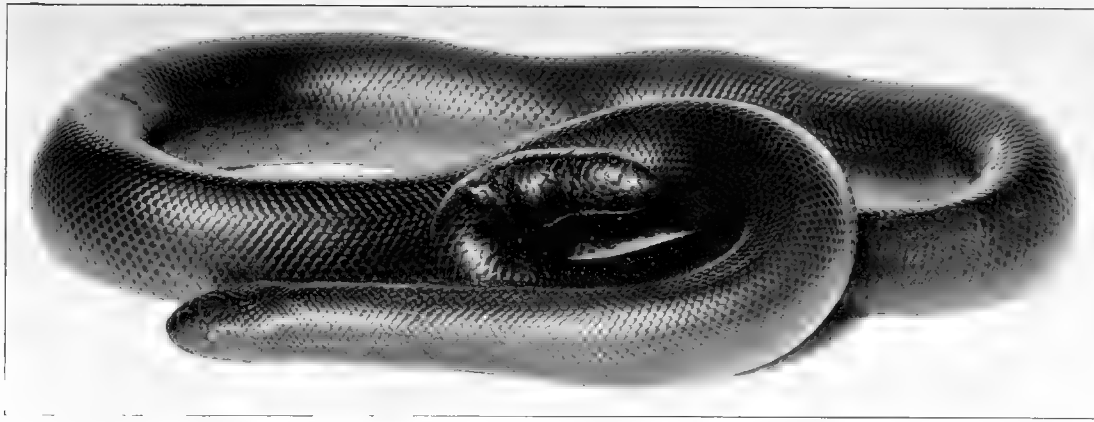

Fig. 3. *Charina bottae* (Blainville). Rubber Snake. Adult female. Little Cottonwood Canyon, Wasatch Mountains, Wasatch County, Utah, June 28, 1913.

Fig. 4. *Bascanion constrictor vetustum* Baird & Girard. Western Yellow-bellied Racer. Provo Canyon, Wasatch Mountains, Wasatch County, Utah, May 23, 1913.

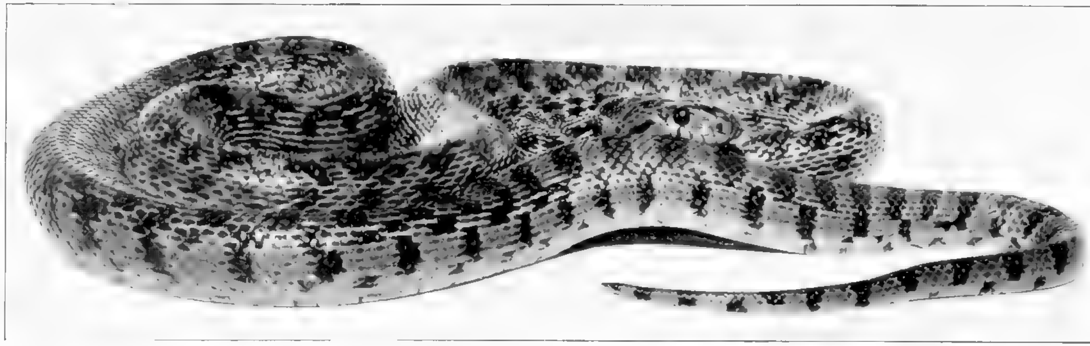

Fig. 5. *Pituophis catenifer deserticola* Stejneger. Desert Gopher Snake. Adult male. Provo Canyon, Wasatch Mountains, Wasatch County, Utah, June 26, 1913.

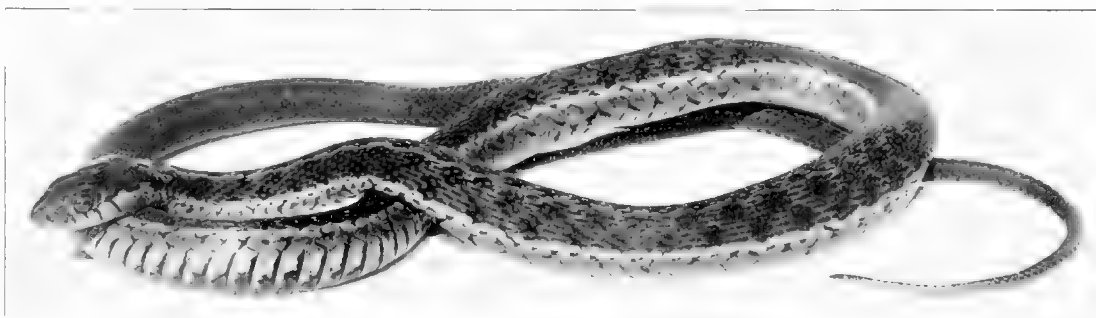

Fig. 6. *Thamnophis vagrans* (Baird & Girard). Wandering Garter Snake. Provo Canyon, Wasatch Mountains, Wasatch County, Utah, June, 1913.

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DESCRIPTION OF A NEW SUBGENUS *(ARBORIMUS)* OF *PHENACOMYS*, WITH A CONTRIBUTION TO KNOWLEDGE OF THE HABITS AND DISTRIBUTION OF *PHENACOMYS LONGICAUDUS* TRUE

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CONTENTS

A INTRODUCTION

Dr. C. Hart Merriam, in describing *Phenacomys albipes* (1901, p. 125), referred to *Phenacomys longicaudus* as being one of the rarest and least known mammals of the world. At that time only three specimens of *longicaudus* had been collected: the type, at Marshfield, Coos County, Oregon, an aberrant specimen at Meadows, Lane County, in the same state, and an example found dead on a road at Lierly's Ranch, near Mt. Sanhedrin, Mendocino County, California. The specimens from Oregon were transmitted to the United States National Museum by Aurelius Todd of Eugene; while the lone example from California, collected by A. S. Bunnell, was part of a collection which went to the Academy of Natural Sciences of Philadelphia.

The species first became formally known to science through the publication of the original description by True (November 15, 1890). For twenty-two years thereafter the species was represented in the museums of the United States by not more than the three specimens mentioned above.

According to Bailey (1915, p. 148) Dr. William Bebb of Los Angeles, in 1907, showed him several specimens of the tree mouse which he had taken at an Oregon lumber camp. "The men were chopping down tall Douglas spruces and he watched when the trees came down and caught several of the stunned or crippled mice as the nests were crushed by the fall."

In 1912 a specimen was secured by a game warden on the slope of Chaparral Mountain above Maplecreek Postoffice, Humboldt County, California, and turned over to Mr. C. I. Clay, of Eureka, who forwarded it to the Museum of Vertebrate Zoology of the University of California. The following year, through the activities of the California North Coast Counties Expedition sent out from the same Museum, sixteen specimens were collected at Mendocino City, Mendocino County, California, and one at Lierly's Ranch, four miles south of Mount Sanhedrin, in the same county. During the spring and fall of 1913, Mr. H. E. Wilder, of Carlotta, Humboldt County, California, collected and transmitted to the Museum of Vertebrate Zoology a series of thir-

teen specimens, one taken at Cuddeback, and twelve at Carlotta, Humboldt County. In February, 1914, Professor John F. Bovard and Mr. Alfred C. Shelton, of the University of Oregon, secured three more on Spencer Butte, seven miles south of Eugene, Oregon; and in June of the same year Mr. Vernon Bailey, of the Bureau of Biological Survey of the United States Department of Agriculture, collected an additional specimen in the same locality.

During these later years other specimens, of which the present writer has no record, may well have been collected; for the species is fairly abundant and widely distributed in certain sections of the humid coast belt, and its meager representation in collections is obviously to be accounted for through ignorance of its habits rather than any actual rarity.

Doubtless a few residents in localities where the species occurs have long known of its existence. Our attention, while working at Mendocino City, was first called to it by small boys. In a letter to the writer Mr. Wilder states that middle-aged men have told him of getting these "red mice" around the school house when they were pupils there.

The comparative recency of knowledge of *Phenacomys longicaudus* on the part of systematists, and the poverty of material representative of it, have had two effects, one beneficial, the other detrimental: The species has been preserved from the burden of synonymy which so involves all our more widely known species, it never, in fact, having been known by any other name than the one which it bears at present; and it has previous to the present time been impossible to determine with any definiteness the systematic and ecologic status of the species. This paper aims to be a contribution to the latter problem.

It should perhaps be here noted that the name "lemming-mouse," which has been applied to *Phenacomys,* is not strictly correct. For this name should be reserved for the members of the supergeneric group of the *Lemmi,* which includes *Synaptomys, Dicrostonyx* and *Lemmus.* On the other hand *Phenacomys* belongs to the supergeneric group of the *Microti,* or voles, which includes also *Fiber, Evotomys* and *Microtus* (see Miller, 1896, p. 8).

As regards their habits the *Microtinæ* are notably adaptable. The situations in which they are found are many and varied. They are encountered ". . . from sea beaches to marshes and Alpine mountain tops, and from open plains to the densest forests . . . . While the great majority of species spend much of their time on the surface, protected by the overhanging vegetation, a few live almost exclusively underground, and in consequence of this habit have acquired numerous modifications which fit them for the needs of a subterranean life. Others are amphibious and never occur at any great distance from water" (Miller, 1896, p. 10). Of all members of this great subfamily, *Phenacomys longicaudus* is unique in its choice of an arboreal habitat; and we may well inquire as to whether this peculiar habit may not be weighted as of importance in the classification of the species. The use of habit characters is not without precedent in the *Microtinæ*. Before the publication of De Selys Longchamps' "Essai Monographique sur les Campagnoles des environs de Liege," 1836, the voles had been divided into two groups according to their habits, the aquatic species being separated from those that are strictly terrestrial. But beginning with and subsequent to this author habits as characteristics of the organism appear to have been left out of count in the classifications of the group.

Miller (1896, p. 24) has clearly shown the impracticability of the subdivision of the genus *Microtus,* and the same holds with regard to the subfamily *Microtinæ,* according to the variations in any *one* set of characters, and in his own work bases the classification upon an assemblage of characters, all drawn from the province of *physical* peculiarities. Of these the following are regarded as the more important: form of skull, structure of bony palate, pattern of enamel folding, number of mammæ, number of plantar tubercles, and presence or absence of musk glands on the sides. Regarded as of lesser importance are: quality of fur, hairiness of soles, length of tail, form of front feet, size of eyes, and form of external ear.

It would appear that the greater the assemblage of characters on which a classification is based, so long as such characters are comparable in degree of constancy, the more ade-

quate the classification. In the present paper characters have been freely drawn from two important additional provinces, namely those of *geographical distribution* and of *habits.*

In general, characteristics from these provinces are not sufficiently well known to permit of their use to any great extent. Confessedly, also, such characters, especially those from habits, are often less tangible and far less convenient than physical characters, but as information is accumulated they must certainly find larger place in taxonomic considerations.

In view of the aberrant nature of *Phenacomys longicaudus* there would seem to be some argument for the erection of a new genus for its reception. It seems to the writer, however, that a principle given expression by several authors, notably Osgood (U. S. Dept. Agric., Bureau Biol. Surv., N. Amer. Fauna 28, 1909, pp. 24, 25), and Sumner (Science, June 18, 1915, pp. 899-902), should be recognized, namely, that in a classification which is inevitably critically analytic, the synthetic phase should not be forgotten. The multiplication of genera for the purpose of emphasizing group differences which are comparatively slight would seem to be unwise.

In the present instance, particularly, the chance that the fundamentally close relationship of *Phenacomys longicaudus* to the genus *Phenacomys* will be overlooked is greater than the chance that its differences therefrom will not be appreciated, so it has seemed wisest to accord it subgeneric rank only.

The chief characteristic of our knowledge of mammalian life-histories is its incompleteness. It is estimated that of even our best known species the life-history material available is only five to twenty-five per cent of what it should be. These considerations emphasize the obligation imposed upon the investigator to put on published record such facts regarding habits as he may discover.

While it is to be hoped that the study of morphology will be no less vigorously prosecuted in the future than in the past, it would seem desirable that the study of psychological predilections and associational relations be much more emphasized in the future than in the past. Habits and associa-

tional relations are just as much a part of the animal as are its physical characters. They are just as distinctive specifically; and there is no good reason why they should not be accorded just as full treatment.

B MATERIAL AND ACKNOWLEDGMENTS

The following specimens constitute the material basis for this study:

Phenacomys intermedius—Total number, 3. Alberta, head of Smoky River, 2 (U. S. National Museum). British Columbia, South Fork Moose River, 4525 feet, 1 (U. S. National Museum).

Phenacomys orophilus—Total number, 17. Washington: Mt. Rainier, 5000 feet, 2 (U. S. National Museum). Montana: Bear Tooth Mountains, 1 (Biol. Surv. Coll.). Idaho: Sawtooth, 2; Salmon River Mountains, 1 (all from Biol. Surv. Coll.). Oregon: Lane County, Three Sisters Mountain, North Base, 5000 feet, 1 (Coll. Univ. Oreg. Mus. Dept. Zool.); Lane County, Three Sisters Mountain, N. W. slope, 7400 feet alt., 1 (Coll. Oregon Game Department); Crook County, Deschutes River, Mouth of Davis Creek, 1 (Coll. Oregon Game Department). California: Mt. Shasta, Squaw Creek, alt. 7800 feet, 2 (1, skull only); Mount Shasta, head of Squaw Creek, 1; Tuolumne Meadows, 2; Mt. Lyell, 2; Mono Pass, 1 (all from Biol. Surv. Coll.); Pyramid Park (= Peak), 1 (Coll. Field Mus. Nat. Hist.). Canada: Northwest Territory, Red Deer River, 1 (Coll. Field Mus. Nat. Hist.).

Phenacomys albipes—Total number, 2. Oregon: Lane County, 2 miles W. of Vida, 1 (Coll. Oregon Game Department). California: Humboldt Bay, Arcata (in redwoods), 1 (the type, Biol. Surv. Coll.).

Phenacomys olympicus—Total number, 9. Washington: Happy Lake, 8; Boulder Lake, 1 (all from Coll. Field Mus. Nat. Hist.).

Phenacomys longicaudus—Total number, 37. Oregon: Coos County, Marshfield, 1 (the type, U. S. National Museum); Lane County, Meadows, 1 (Biol. Surv. Coll.); Eugene, 4 (1 from Biol. Surv. Coll., 3 from Coll. Univ. Oreg. Mus.

Dept. Zool.). California: Humboldt County, Mad River, Big Bend, southeast from Kneeland, Chaparral Mountain, on slope above Maplecreek Post Office, 12; Carlotta, 12; Cuddeback, 1; Mendocino County, Mendocino City, 16 (4 in alcohol); Lierly's Ranch, 4 miles south of Mount Sanhedrin, 1 (all Coll. Mus. Vert. Zool. Univ. Calif.).

The writer desires to extend grateful and cordial acknowledgment to the following persons: For the loan of specimens, to Messrs. H. W. Henshaw and E. W. Nelson, of the Bureau of Biological Survey of the U. S. Department of Agriculture, to Messrs. Richard Rathbun and Gerrit S. Miller of the U. S. National Museum, to Mr. Wilfred H. Osgood, of the Field Museum of Natural History, to Mr. Alfred C. Shelton of the University of Oregon Museum, Department of Zoology, and to Mr. Stanley G. Jewett, of the Oregon Game Department; for identification of lichen used as nest material by the tree mouse, to Professor William A. Setchell, Professor of Botany, University of California; for microscopical examination of nest material to Dr. T. H. Goodspeed of the University of California; and for much valuable information as to the habits of the tree mouse to Mr. Alfred C. Shelton, of the University of Oregon, to Mr. C. I. Clay, of Eureka, California, to Professor Walter K. Fisher of Stanford University, and to Mr. H. E. Wilder, of Carlotta, Humboldt County, California. References in the text to Messrs. Shelton, Fisher, Clay and Wilder are on the basis of their correspondence with the writer. The success of the expedition sent out by the Museum of Vertebrate Zoology to the north coast counties of California, which collected material representative of *Phenacomys longicaudus* and much valuable information regarding its occurrence and habits, is in no small measure due to the following men, who accompanied the writer, and whose enthusiastic co-operation made the work a pleasure: Mr. Gordon F. Ferris, of Stanford University; Mr. Charles L. Camp, of the University of California; and Mr. Alfred C. Shelton, formerly of the University of California.

The writer takes this occasion also to express his appreciation of the valued criticisms and suggestions furnished by Dr. Joseph Grinnell of the University of California under whose immediate supervision the work was carried on.

C *ARBORIMUS*, A NEW SUBGENUS OF *PHENACOMYS*

I GEOGRAPHIC DISTRIBUTION OF TYPE SPECIES AND SUBGENUS.

Phenacomys longicaudus True, the type species of the new subgenus, is found in southwestern Washington and northwestern California. *Phenacomys albipes,* tentatively referred to *Arborimus,* occurs in the same general locality. (See map, fig. 4, p. 137.)

II ESSENTIAL CHARACTERS OF *Arborimus.*

Palate tending to be different posteriorly from that in the subgenus *Phenacomys.*

M^3 with second outer triangle tending to be closed off from posterior loop; posterior loop tending to be more rounded, and less emphatically drawn out antero-posteriorly than in *Phenacomys.*

Triangles and loops of M_1 tending to open into one another, except in *albipes.*

Antero-external loop of M_2 never closed off, tending to be smaller than in most examples of *Phenacomys.*

Outer triangle on M_2 tending to be smaller and to open into opposing triangles, except in *albipes.*

M_3 ordinarily simpler than in *Phenacomys,* practically three transverse crescents without external triangle.

Interorbital constriction tending to be narrower than in *Phenacomys.*

Tail proportionally decidedly longer than in *Phenacomys.*

Color a brilliant reddish, except in *albipes.*

Habit arboreal, except in *albipes,* nesting and apparently living entirely in trees.

Distribution, humid coast belt of southwestern Oregon and northwestern California, a section in which no specimen of the subgenus *Phenacomys* has ever been found.

III DESCRIPTION OF *Phenacomys longicaudus* TRUE

1 CRANIAL CHARACTERS

(1) Skull in general

Similar in general characters to that of *Phenacomys.* Crania of *Phenacomys (Arborimus) longicaudus* have broader brain-

case than those of *P. (Phenacomys) intermedius,* much as in *P. (Phenacomys) orophilus.* The narrower interorbital constriction is the most certainly diagnostic character of the crania of members of the new subgenus (see table of measurements). Palate posteriorly tends to be different in *Arborimus,* usually having lateral pits a little deeper, sloping portion of median ridge longer, and lateral bridges more often present. In *Phenacomys* the lateral pits tend to be shallower, the sloping portion of the median ridge is shorter, in some specimens almost obsolete, and the lateral bridges are more often absent than present. There is overlapping between the subgenera in this respect. Young individuals of *longicaudus* tend to resemble *orophilus* and *intermedius.*

A Cranial measurements comparative of
Phenacomys (Arborimus) longicaudus and *Phenacomys (Phenacomys) orophilus*

(All measurements in millimeters)

Museum No.	Sex	Greatest length	Zygomatic width	Interorbital constriction[1]	Width of cranium outside external auditory meatus
			Phenacomys orophilus		
205916	♂	25.8	15.1	3.5	12.0
109103	♂	26.6	......	3.9	12.2
67327	♂	25.7	14.9	3.6	11.7
110249	♀	25.0	14.9	3.8	11.5
			Phenacomys longicaudus		
21145	♂	24.4	14.3	3.0	11.1
21148	♂	24.4	13.9	3.4	11.6
19983	♀	26.1	14.6	3.3	12.4
19174	♀	25.0	15.1	3.4	11.9
21149	♀	25.0	14.2	3.2	11.6
21143	♀	25.2	14.4	3.2	12.4
19973	♀	25.1	14.1	3.3	12.2
19130	♀	24.6	14.3	3.4	11.5
19984	♀	25.8	14.9	3.5	12.4

[1]Miller remarks (1897, p. 80) that the breadth of the interorbital region in *Phenacomys* is a character of trifling importance, which might easily disappear with increasing age. But the character as a good diagnostic feature would seem to hold between the series before me, since the specimens compared are good adults, with the examples of *orophilus* averaging older than those of *longicaudus.*

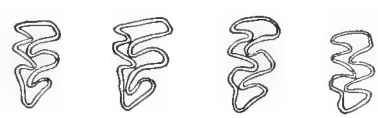
Enamel pattern in *Phenacomys longicaudus* simpler than in certain representatives of the subgenus *Phenacomys,* but not presenting any characters in all cases diagnostic of the new subgenus. The first and second upper molars are practically

identical with those in the subgenus *Phenacomys,* and will not be discussed separately. The front upper molar has, beginning anteriorly, a transverse loop, two inner triangles, one outer triangle, and a postero-external loop. The middle upper molar has transverse loop, one outer triangle, one inner triangle, and a postero-external loop.

(2) Back upper molar

Pattern practically as in the subgenus *Phenacomys.* Beginning anteriorly, the tooth shows a transverse loop, an external triangle, an internal triangle, a second outer triangle, and a postero-internal loop.

In the subgenus *Phenacomys* the outer portion of the posterior "trefoil" ordinarily opens into the inner portion, forming a figure crescentic or boomerang-shaped in outline, the concavity of the crescent or boomerang being directed forward. Sometimes the crescent or boomerang is symmetrical, but usually the inner arm is the heavier. In *Phenacomys longicaudus* the outer portion of the crescent tends to be closed off from the inner portion, forming a second triangle externally and a loop internally, the loop tending to be more rounded than is ordinarily the case in the subgenus *Phenacomys.*



1 2 3 4

Fig. 1—ENAMEL PATTERN OF BACK UPPER MOLARS OF *PHENACOMYS.*

From left to right these belong to the following species: No. 1, *Phenacomys (Phenacomys) intermedius;* No. 2, *Phenacomys (Phenacomys) orophilus;* No. 3, *Phenacomys (Arborimus) albipes;* No. 4, *Phenacomys (Arborimus) longicaudus.* Traced from photograph. A little less than six times natural size.

Note the development of the second outer triangle and the general difference in outline posteriorly in the new subgenus *Arborimus.*

There is some variation in the tightness of the closure of the second outer triangle in *longicaudus.* In the young the triangle is scarcely formed. In its place is a channel, opening broadly both forward and back and showing on its external

outline a weakly developed salient angle which later becomes the strongly developed salient angle of the triangle. One specimen of *longicaudus* (No. 19976) is unusual in having the second outer triangle opening into the inner triangle forming with it a transverse loop which opens very narrowly into the posterior loop. In a few examples of *longicaudus* (Nos. 21143, 19130, 19174, 19985, and 21154) the second outer triangle opens narrowly into the posterior loop.

In all examples of the subgenus *Phenacomys* at hand, except in one specimen of *P. orophilus* (No. 101058), the outer portion of the crescent or boomerang is not closed to form a second outer triangle, but communicates, usually broadly, with the inner portion.

In the original description of the genus *Phenacomys,* Merriam states (1889, p. 31) that sometimes the outer loop of the trefoil is closed, giving the tooth two external closed triangles and a postero-internal loop. Elliot's illustration (1899b, p. 255) of the upper tooth-row of *olympicus* shows the second outer triangle closed as in *longicaudus.* A cut of the upper tooth-row of *orophilus* published by Merriam (1891, opp. p. 130, pl. III, fig. 3) shows a small second outer triangle closed off from the postero-internal loop, as in *longicaudus.* Similar relations hold in another illustration in the literature (Elliot, 1901, p. 167).

It is clear from these facts that *longicaudus* could not be certainly identified on the enamel pattern of the back upper molar. But there is an average difference between the situation in *longicaudus* and that in subgenus *Phenacomys,* in which latter, ordinarily, the crescent or boomerang looks as if it had been held in the middle while still soft and its arms pulled out anteriorly. In *Arborimus* the outer arm of the crescent becomes the second outer triangle, which is generally closed in both directions, and the postero-internal loop, which is rounded in outline and lies less in an antero-posterior position than the inner arm of the crescent in subgenus *Phenacomys.*

(3) Front lower molar

Agrees with all the species of the genus of which I have material before me in possessing an anterior tripartite trefoil,

with anterior, inner and outer loops all broadly communicating, three long inner and two short outer triangles, and a posterior transverse loop. Certain specimens (as *Phenacomys longicaudus* Nos. 19979 and 21150) have the outer loop of the anterior trefoil closed to form an additional outer triangle. In one specimen of *longicaudus* (No. 42621) both inner and outer loops of the anterior trefoil are constricted to form triangles, though neither triangle is completely closed. The small anterior loop in this specimen bends sharply inward. No. 42621, therefore, has a small anterior loop, four inner and three outer triangles, and posterior transverse loop.

The species of the genus differ more or less constantly in the tightness of closure of loops and triangles. There prevails in *longicaudus* the most open condition which I have observed in the genus; in *albipes* and *intermedius* the closure is tighter; and in *orophilus* it is tightest of all.

No. 21147 is unique among the specimens of *longicaudus* in having the inner reëntrant angles so deep that the second outer triangle is not in evidence. Ordinarily the second inner triangle is closed off from the second outer triangle, while the third inner triangle is not closed. In No. 19983, however, the reverse is true. In one or two examples the molar pattern is slightly different on right and left sides. Teeth which are much worn have the reëntrant angles transformed into lakes, and do not show the enamel pattern characteristic of earlier ages.

In most of the specimens of *longicaudus* the first inner triangle opens into the outer loop of the anterior trefoil, while in *albipes* and in a majority of the specimens of *orophilus* before me it is closed. In three specimens of *intermedius* a narrowly open condition is observed, but in the type specimen of *intermedius,* as figured by Merriam (1889, pl. IV, opp. p. 44), the triangle is closed. Two specimens of *longicaudus* (Nos. 21152, 21147) have the first inner triangle closed off from the outer loop of the anterior trefoil. In No. 19983 the triangle is open on one side but closed on the other, and it is only very narrowly open in two or three examples, notably No. 19130. In most young individuals of *orophilus* the first

inner triangle is not tightly closed, nor is it in *orophilus* No. 95080.

There are no characters in this tooth which distinguish the subgenus *Arborimus* from certain members of the subgenus *Phenacomys.* In Merriam's original description of the genus he uses the following language with reference to the front lower molar (1889, p. 31): "First lower molar with a posterior transverse loop, four greatly elongated internal triangles or digitations, of which at least two are completely closed, an anterior loop of variable shape, and three short external triangles, of which at least one is completely closed." In the illustration of the enamel pattern of *celatus* in Merriam's plate

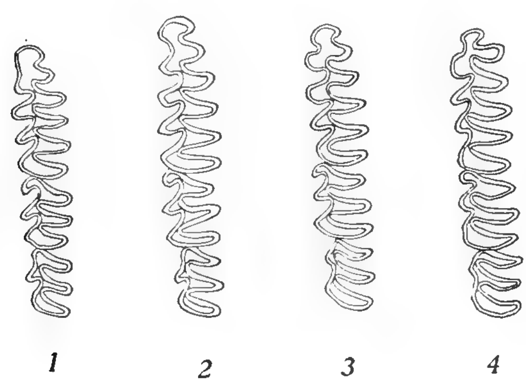


Fig. 2—ENAMEL PATTERN OF MANDIBULAR TEETH OF *PHENACOMYS.*

No. 1, *Phenacomys (Phenacomys) intermedius;* No. 2, *Phenacomys (Phenacomys) orophilus;* No. 3, *Phenacomys (Arborimus) albipes;* No. 4, *Phenacomys (Arborimus) longicaudus.* Traced from photograph. About six and one-fourth times natural size.

Note that in *Arborimus* the antero-external loop of M_2 is not closed and tends to be smaller than in *Phenacomys;* note the peculiar arrangement of the second outer triangle in *longicaudus;* and finally note the comparative simplicity of M_3 in *Arborimus.*

IV, opposite page 44, the first inner triangle is shown opening broadly into the outer loop of the anterior trefoil as in *longicaudus.* In this specimen also the first inner triangle is shown to open broadly into the first outer triangle. On plate III, facing page 42, the first inner triangle in *P. ungava* is shown opening narrowly into the first outer triangle. Miller (1896, p. 41) has figured the enamel pattern of *celatus.* According to his illustration the first inner triangle opens narrowly both forward and back. These are the only instances I have noted in the literature in which conditions are found similar to those in *longicaudus.*

It seems safe to conclude that *longicaudus* is characterized, with qualifications as above noted, by a more open condition of the loops and triangles of this tooth than in the subgenus *Phenacomys.*

(4) Second lower molar

Similar in pattern to *Phenacomys intermedius,* the type of the genus *Phenacomys.* Small antero-external loop, elongated antero-internal triangular digitation, one short outer triangle, one long inner triangle, and a posterior transverse loop.

The small antero-external loop is never closed in *longicaudus.* In one specimen of *intermedius* (No. 174425) the loop is larger than in any specimen of *longicaudus,* with the possible exception of No. 21143, opening broadly into the opposing triangle; in another specimen of *intermedius* (No. 174431) the antero-external loop is only narrowly open; while in a third (No. 174432) the loop is large and opens broadly. All specimens of *orophilus* at hand, with the exception of Nos. 205916 and 67327, have this loop tightly closed off from the opposing triangle. In Merriam's figure 7, illustrative of the genus *Phenacomys* (1889, p. 31) the loop is tightly closed. In his plate III, facing page 42, the antero-external loop both in *celatus* and *ungava* is broadly open as in *longicaudus.* Plate IV, opposite page 44, shows the antero-external loop opening broadly in *latimanus* as well as in *celatus* and narrowly in *intermedius.* In Miller's figure of *celatus* (1896, p. 41) the same relations are shown.

The outer triangle in *longicaudus* tends to be of comparatively small size and not tightly closed off from the antero-internal triangle and the opposed inner triangle. In most specimens the outer triangle opens rather broadly into the opposed inner triangle and narrowly, if at all, into the antero-internal triangle. In *intermedius* the outer triangle is larger than in *longicaudus,* and is closed off in both directions. In *orophilus* there is a considerable range of individual variation in this respect. In four adult examples (Nos. 109103, 67327, 110249, and 205916) the outer triangle is large and is closed.

According to Merriam's plate IV (1889, opp. p. 44) the outer triangle in *latimanus* opens very narrowly anteriorly.

Summarizing, it may be said that while in the subgenus *Phenacomys* the antero-external loop is often closed, it never is in *Phenacomys (Arborimus) longicaudus;* there is also apparent a tendency in the latter for the outer triangle to be smaller and more open than in the subgenus *Phenacomys.*

(5) Third lower molar

Typical of the genus, being made up of three transverse triangular digitations connected along the outer border of the tooth. Tending to be simpler in *P. longicaudus* than in the subgenus *Phenacomys,* in which there is often if not usually a small outer triangle pinched off opposite the middle transverse triangular digitation.

In one specimen of *longicaudus* (No. 21150) this little outer triangle is definitely outlined, though it is not closed off. Similar conditions obtain in several other specimens. There is considerable variation in *orophilus.* In two specimens (Nos. 31249 and 75029) no triangle is outlined, and this is true in several young examples also; but in most adult examples the little triangle is emphasized and tightly closed. In *intermedius,* type of the genus, the triangle is well developed, being practically closed in Nos. 174431 and 174432, but opening posteriorly in the right molar of No. 174425.

Summarizing, in *longicaudus* an outer triangle on the third lower molar is never isolated in the sense of being tightly closed. In the subgenus *Phenacomys* there is a tendency for an outer triangle to be isolated in this manner.

2 EXTERNAL CHARACTERS

(1) General coloration

While certain young examples (notably Nos. 137, 138, 139, Univ. Oreg. Mus.) are somewhat paler than the rest, the entire series of thirty-three skins before me is remarkably uniform in general coloration, being cinnamon dorsally, paling to light ochraceous-buff on the sides, and becoming white ventrally. Tail usually colored a very dark brown, near seal brown, with no demarcation between dorsal and ventral coloration.

(2) Dorsal coloration

A rich cinnamon, the exact hue varying from near orange-cinnamon (as in No. 21149, a specimen of middle age) to near ochraceous-buff (as in No. 19980, a very young specimen). The majority of the specimens are cinnamon or pinkish cinnamon on the back, and all have a greater or less insprinkling of spiny black hairs, which tend to give a darker appearance than would otherwise be the case. Eight young examples are quite close to No. 19980 in coloration.

The hairs of the contour pelage are deep plumbeous basally, the lighter portion of the shaft being confined to the tip. On nose and around eyes the hairs are shorter and lack the plumbeous bases. In most of the specimens the short hairs on the extreme tip of the nose are near light seal brown. Whiskers silvery or blackish brown, the silvery hairs often having blackish-brown bases. The combination of short ears and rather long hair makes the ears inconspicuous. In some specimens (notably Nos. 19985, 21145, 19984, 19975, 19980, 19978) the ears are almost concealed. In all examples the long hairs of the body pelage overlie the opening into the ear. The pinna of the ear itself is very thinly haired, within and without, with hairs similar in coloration to those making up the contour pelage of the body, except that there is a tendency for the plumbeous bases to be absent. Toward the base of the pinna the typical body pelage is encountered.

Forefeet dorsally with a shade of the buff or cinnamon series somewhat paler than that of the dorsal coloration, ordinarily white on the fingers, but sometimes washed with very pale buff; ventrally white; palm naked; hairs about bases of claws exceeding claws in length. Hind feet whitish, washed with

buffy on toes dorsally, as in No. 19174; or having black hairs insprinkled and a darker shade of buffy, as in Nos. 19974 and 19983; hairs about bases of claws often exceeding claws in length. Sides of body paler than back; the spiny black hairs fewer in number. In a typical example (No. 19174) the color grades from near orange-cinnamon dorsally to light ochraceous-buff laterally.

The peculiarities in coloration of a specimen collected at Meadows, Lane County, Oregon, have already been commented on in the literature (Miller, 1897a, p. 85; Merriam, 1901, p. 126; and see below, p. 131).

(3) Ventral coloration

White, sometimes with plumbeous bases of hairs showing through to some extent, often with the faintest possible wash of buffy. In adult females the positions of the two pairs of abdominal mammæ are marked by sparsely-haired circular patches a quarter to one-half inch in diameter. Hairs of throat and of nipple patches have no plumbeous bases. Sometimes hairs posteriorly on belly in vicinity of nipple patches also lack plumbeous bases.

Tail varying in coloration, in different examples, from pinkish-cinnamon to blackish-brown. Although there is in some specimens the faintest possible tendency toward ventral paling, in a large majority there is no discernible difference in coloration between the upper and lower sides. Most of the series have the tail tipped with a pencil of blackish-brown hairs. In No. 21153 all the tail except the tip is pinkish-cinnamon. Consequently the blackish-brown tip is very conspicuous. Ordinarily the general tail coloration is so dark that no contrast is observable.

(4) Length of tail

Miller (1897a, p. 79), in his key to the genus *Phenacomys*, sets off *longicaudus* as having a tail forty per cent of its total length, while the remaining species, including *ungava, latimanus, intermedius, preblei,* and *orophilus,* are grouped as having tails only twenty-five per cent of total length.

An examination of the available series of thirty-seven specimens of *longicaudus,* in connection with the study of the other examples of *Phenacomys* at hand and of all published measurements, enables the writer to confirm the validity of this

grouping. Of the series of *longicaudus*, No. 19985, a young adult, has the tail 44.2 per cent of its total length. No. 19976, also a young adult, is next, with the tail 42.5 per cent of total length. The largest and oldest individual of all, No. 19984, follows with tail 42.4 per cent total length. The smallest and youngest example of *longicaudus* measured to date (No. 20657, preserved in alcohol) has tail only 25.7 per cent of total length. Young animals are all characterized by low ratios, and as the scale of age is ascended the ratio increases.

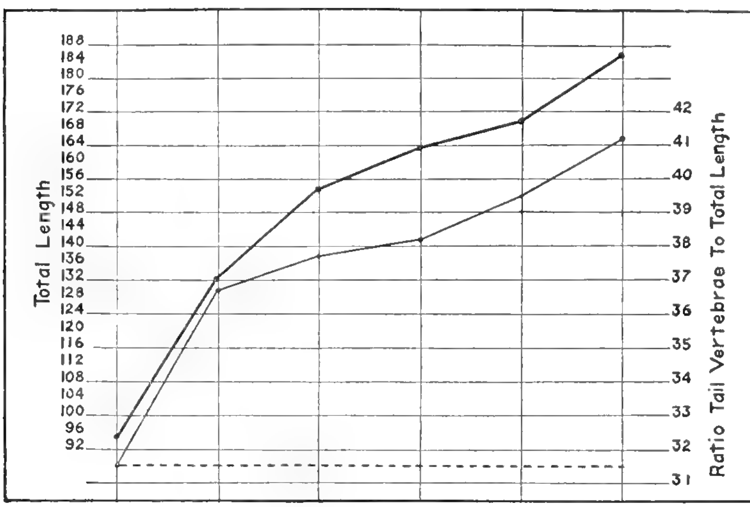


Fig. 3—INCREASE IN RATIO OF LENGTH OF TAIL VERTEBRÆ TO TOTAL LENGTH WITH AGE.

The heavy black line represents the actual total length (correlated with age); the light black line the ratio of the length of the tail vertebræ to total length. Each round dot represents the average for six individuals. The pair of dots on each vertical line pertain to the same six individuals. Read scale for actual total length on the left side of the diagram, and scale for ratio of the length of the tail vertebræ to total length on the right side. Note that if the ratio of the length of the tail vertebræ to total length remained constant with increasing age at the figure for the smallest group, the ratio would be indicated by a horizontal line, as dotted in the figure. But instead of this, the ratio undergoes a steady increase with age.

Of the other species of the genus, *P. albipes* makes the nearest approach to *P. longicaudus*, the two known specimens of this form having ratios of tail vertebræ to total length of 36.9 and 40.0 per cent respectively. Three skins of *P. inter-*

medius at hand (Nos. 174431, 174425, and 174432, U. S. Nat. Mus.) show ratios of 28.6, 34.3, and 29.3 per cent respectively; while two skins of *orophilus* (Nos. 109103 and 109102, Biol. Surv. Coll.) show ratios of 30.5 and 28.1 respectively. Of thirty-six specimens, representing eleven different species of the subgenus *Phenacomys,* the measurements of which are recorded in the literature, in only two does the ratio exceed 26.0 per cent, and in the majority it falls below 25.0. More

B External measurements of three species of the genus *Phenacomys*
(All measurements in millimeters)

Museum No.	Sex	SPECIES AND LOCALITY	Total length	Tail vertebræ	Hind foot	Ratio tail vertebræ to total length
		Phenacomys albipes				
97236	♂ ad.	California: Humboldt Bay (Arcata —in redwoods)	168	62	19	36.9
797	♂ ad.	Vida, Lane Co., Oregon	165	66	19	40.0
		Phenacomys orophilus				
109103	♂ ad.	California: Tuolumne Meadows	154	47	18	30.5
67327	♂ old ad.	Montana: Bear Tooth Mountains	142	33	17	23.2
110249	♀ yg. ad.	California: Mt. Lyell	153	41	17	26.8
110251	♂ yg. ad.	California: Mt. Lyell	121	28	17	23.1
23849	♂ yg.	Idaho: Salmon River Mountains	120	28	18	23.3
109102	♀ yg.	California: Tuolumne Meadows	114	32	16	28.1
		Phenacomys intermedius				
174431	♂ ad.	Alberta: Head of Smoky River	98	28	19	28.6
174425	♀ ad.	British Columbia: Moose River	105	36	19	34.3
174432	♀ ad.	Alberta: Head of Smoky River	106	31	19	29.3

than that, the average ratio of thirty-one additional specimens, representative of the subgenus *Phenacomys,* falls below 26.0 per cent. These specimens constitute all of which measurements have been found by the writer in the literature.

Miller (1896, p. 24) asserts that length of tail in the *Microtinæ,* being more unstable than certain other characters because more readily modified to fit a species to special requirements of its environment, is less important than these other characters in the diagnosis of subgenera. It would seem to the writer, however, that such a marked difference as seems to hold in this respect between the *albipes-longicaudus* group on the one side and the other species of *Phenacomys* on the other should be regarded as of at least subgeneric value.

(5) Tuberculation of feet and the number of mammæ

A young example of *Phenacomys longicaudus* (No. 20658), preserved in alcohol, has five tubercles on the fore feet; the reduction of the thumb to a small tubercle makes the fore feet appear to have an additional tubercle. The hind feet are six-tuberculate.

Longicaudus has two pairs of mammæ placed far back on the belly. The only reference to the number of mammæ in the genus *Phenacomys* which I have been able to find in the literature is that of Miller (1897b, p. 22), in which a female of *P. latimanus* is stated to have eight mammæ, four pectoral and four inguinal. A difference in number of mammæ may characterize the two subgenera.

(6) The type of *Phenacomys longicaudus* True

This specimen has been several times described and the condition of its skull commented on (True, 1890, p. 303; Miller, 1897a, p. 85; Merriam, 1901, p. 126; Lyon and Osgood, 1909, p. 96). Tooth pattern in No. 19974 of our series from Mendocino City practically the same as in the type; and external characters show clearly that specimens in our collection are almost identical with the type.

(7) The specimen from Meadows, Lane County, Oregon

Miller (1897a, p. 85) has described the aberrant specimen from Meadows, Lane County, Oregon (♀, No. $\frac{30649}{42621}$ U. S. Nat. Mus., Biol. Surv. Coll., taken April 13, 1891), in the following words: "Head, back and sides pale yellowish drab, the fur light bluish plumbeous at base and sprinkled with inconspicuous dark hairs; belly grayish white, the bluish bases of the hairs showing through irregularly; tail indistinctly bicolor, light slaty gray above and at tip, whitish mixed with gray below; feet silvery white." Merriam (1901, p. 126) refers to the same specimen as being pale buffy fulvous, and remarks that it seems to be a partial albino.

(8) Pelages

Specimens are available representative of every month in the year except September and December. Examples with the longest hair were collected during the winter months (notably No. 19130, taken January 6, and No. 19174, March 27).

The shorter the pelage the greater is the tendency for the plumbeous bases of the hairs ventrally to show through, consequently differences in length of pelage are more readily perceptible below than they are above. Applying this test to our series of *P. longicaudus* it is noted that spring and summer skins tend to have shorter pelage than those taken at other times of year.

No. 21143, collected April 20, has the pelage comparatively thin. Ten specimens, taken October 24 and 25, are not conspicuously different from those collected in July.

There is a not readily tangible tendency toward paleness in the summer skins. The slightly darker shade noted in the winter examples is apparently due to the longer cinnamon tipping rather than to any real difference in hue.

No molt lines or other indications of molt, aside from the slight difference in length of hair, are observable. Whether there is a definite time of molt cannot be stated. It is not improbable that there is a gradual hair renewal late in the fall, perhaps during November, and that the "summer pelage" is simply the worn winter pelage remaining over from this molt.

IV Relations of *Phenacomys albipes* to the two subgenera of *Phenacomys*

The complex of its characters relates *Phenacomys albipes* more closely to *P. longicaudus* than to any other known form of the genus, as was implied by Merriam in the original description (1901, p. 125). For thirteen years the type specimen of *albipes* remained unique, and it is only recently that a second specimen has been collected (see Jewett, 1915, pp. 37-38).

Cranially *Phenacomys albipes* stands off by itself. Its skull, as compared with that of *orophilus, intermedius,* and *longicaudus,* has an appearance of length and narrowness (see Plate 15). Testing by actual measurement we find that there is no clear dimensional difference in greatest length (see tables of cranial measurements), *albipes* being exceeded by four of the nine specimens of *longicaudus* measured, and by three of the four specimens of *orophilus* measured. The zygomatic arches, however, do not spread so widely in *albipes* as in *longicaudus, orophilus* or *intermedius.* In fact, this dimen-

sion, as given in the tables of measurements, is less in *albipes* than in any specimen of these species measured, with one exception, an example of *intermedius* (No. 174431), in which the dimension is the same as that in *albipes*. In width of

C Cranial measurements comparative of
Phenacomys (Arborimus) albipes and *Phenacomys (Phenacomys) intermedius*

(All measurements in millimeters)

Museum No.	Sex	Species	Greatest length	Zygomatic width	Interorbital constriction	Width of cranium outside external auditory meatus
				Phenacomys albipes		
97236	♂		25.6	13.8	3.3	11.3
797	♂		25.1	......	3.7	11.2
				Phenacomys intermedius		
174431	♂		23.8	13.8	3.7	11.0
174425	♀		24.9	14.2	3.6	11.0
174432	♀		24.3	14.3	3.7	11.1

interorbital constriction one specimen of *albipes*, No. 97236, agrees with *longicaudus*, while the other, No. 797, is closer to *intermedius* and *orophilus;* in width of cranium outside of external auditory meatus the examples of *albipes* are less than those of *orophilus* but greater than those of *intermedius*. Eight of the nine comparable specimens of *longicaudus* exceed *albipes* in this measurement.

Back upper molar in *albipes* has the outer portion of the posterior crescent closed off to form a second outer triangle. In the type (No. 97236), the second outer triangle is closed off from the inner portion of the crescent in this tooth on both sides. In the second specimen (No. 797), there is a tendency for the second outer triangle on the left hand side to open very narrowly into the interior part of the crescent. In this character *albipes* is closest to *longicaudus*. The inner loop is intermediate in position and outline between *orophilus* and *longicaudus,* tending, in No. 97236, in the direction of *orophilus,* and in No. 797 in the direction of *longicaudus*. Whereas in the type (No. 97236) the triangles and loops of the front lower molar are for the most part closed off from one another, in No. 797 they tend narrowly to intercommunicate. The tight closure of these loops and triangles is observed often in, if not characteristic of, the subgenus *Phenacomys*,

whereas the open condition is typical of *longicaudus*. Antero-external loop of second lower molar as in *longicaudus*. Outer triangle on same tooth moderate in size, often opening very narrowly forward or back, practically intermediate in condition between *longicaudus* and the *orophilus-intermedius* series. Back lower molar as in *longicaudus*.

In coloration dorsally and laterally *albipes* has been described as "grizzled bister" differing from the grayish or light brownish *orophilus-intermedius* series in being darker, and from *longicaudus* in being browner. Its general aspect is much like that of *Evotomys californicus*. The coloration of the lighter hairs is of a tint a little paler than the cinnamon of *P. longicaudus*, from which *albipes* differs markedly in having a much larger proportion of black hairs. Laterally there is an inconspicuous paling, the result of a slight increase in the number of hairs of a cinnamon or buffy hue. Ventrally *albipes* is white, as in *longicaudus*, but with a faint wash of buffy, as in *Evotomys californicus*. Feet white. Tail sharply bicolor, "dusky" above and "broadly whitish" below. The tail is also longer than in any other species of the genus except *longicaudus* (see p. 129, above).

As may be inferred from the fact that only two specimens of *albipes* have been taken to date the habits of the form are practically unknown. Dr. Walter K. Fisher, who collected the type specimen, informs the writer that the type was taken in a trap set close to the base of a redwood perhaps two feet in diameter, which formed one of a clump. The trap was set on top of a small rotten log, which leaned against the tree and was covered with "needles." The clump was made up of second growth redwoods and the general surroundings were dry. The second specimen (Jewett, 1915, p. 38), was collected among rocks at the side of a small stream where it flows through a dense forest of spruce and fir timber. At this point both banks of the stream were lined with an almost impenetrable jungle of salmon-berry bushes and sword fern, where jumping mice and deer mice, as well as several species of shrews, were collected. Thus there is no evidence of any arboreal habit in *Phenacomys albipes*.

Summarizing, it should be noted that *Phenacomys albipes* resembles *P. longicaudus* in that there is present on the back

upper molar a second outer triangle, which is practically closed off from the inner loop, the antero-external loop on the second lower molar is open, the enamel pattern of the third lower molar is nearly identical, the geographic range is similar, and the proportionate length of the tail is nearly the same. It differs from *longicaudus* in being darker, in having a faint wash of buffy on the white ventral surface of the body, in its bicolored tail, in the general length and narrowness of its skull, and in its, so far as known, exclusively terrestrial habit. It is practically intermediate between the *orophilus-intermedius* series on the one hand and *longicaudus* on the other in width of interorbital constriction, outline and position of postero-inner loop on back upper molar (closer to *longicaudus* than to the *orophilus-intermedius* series in this character), and outline of outer triangle on second lower molar (perhaps closer to the *orophilus-intermedius* series in this character).

There are several alternatives open in the matter of the disposition of *Phenacomys albipes.* It may be left "of uncertain status"; it may be accorded separate subgeneric rank; or it may be referred to one or the other of the subgenera *Phenacomys* and *Arborimus.* In view of the small amount of material available, there is much to be said in favor of leaving it for the present "of uncertain status." The peculiar slender appearance of its cranium might be regarded as of separate subgeneric value, if it were more striking, or if there were associated with it other characters of importance. Since most of the available evidence seems to point to the disposition of *albipes* as a member of the subgenus *Arborimus,* the species has been assigned thereto by the present writer, but in the absence of more material and information it is emphasized that such reference must necessarily be no more than tentative.

D DISTRIBUTION AND HABITS OF *PHENACOMYS LONGICAUDUS* TRUE

I Distribution

1 in time

No fossil material whatever referable to the genus is known. *"Arvicola" intermedius* Newton (see Miller, 1896, pp. 75, 76) from the late Pliocene Forest Bed of Norfolk, England, referred to *Phenacomys* by Nehring, has recently been associated with a number of other fossil forms in the genus *Mimomys* Forsyth Major. As stated by Hinton with reference to the genus *Mimomys* (1914, p. 474), "its members are amongst the earliest microtines in Britain, having been detected in the late Pliocene Norwich Crag." Consequently this genus is of great interest, although its generalized enamel pattern with reëntrant angles approximately equal shows that it cannot be closely related to *Phenacomys.*

2 in space

Specimens have been actually taken as follows: In Oregon: Marshfield, Coos County; Meadows, Lane County; Eugene, Lane County. In California: Chaparral Mountain, above Maplecreek Post Office, near "Big Bend," Mad River, Humboldt County; Cuddeback, Humboldt County; Carlotta, Humboldt County; Mendocino City, Mendocino County; Lierly's Ranch, four miles south of Mt. Sanhedrin, Mendocino County.

There is little doubt that the tree mouse occurs at many other localities in this general region. Mr. Aurelius Todd,

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Fig. 4—KNOWN RANGE OF *PHENACOMYS LONGICAUDUS,* WITH RECORD STATIONS OF ALL THE *PHENACOMYS* KNOWN TO HAVE BEEN TAKEN IN CALIFORNIA AND OREGON.

(See map on opposite page.)

■ Localities where *Phenacomys orophilus* has been collected

▲ Localities where *Phenacomys albipes* has been taken.

○ Localities where *Phenacomys longicaudus* has been collected.

⊗ Localities where *Phenacomys longicaudus* is known to occur, but no specimens collected as yet.

▦ Area within which *Phenacomys longicaudus* is known to occur.

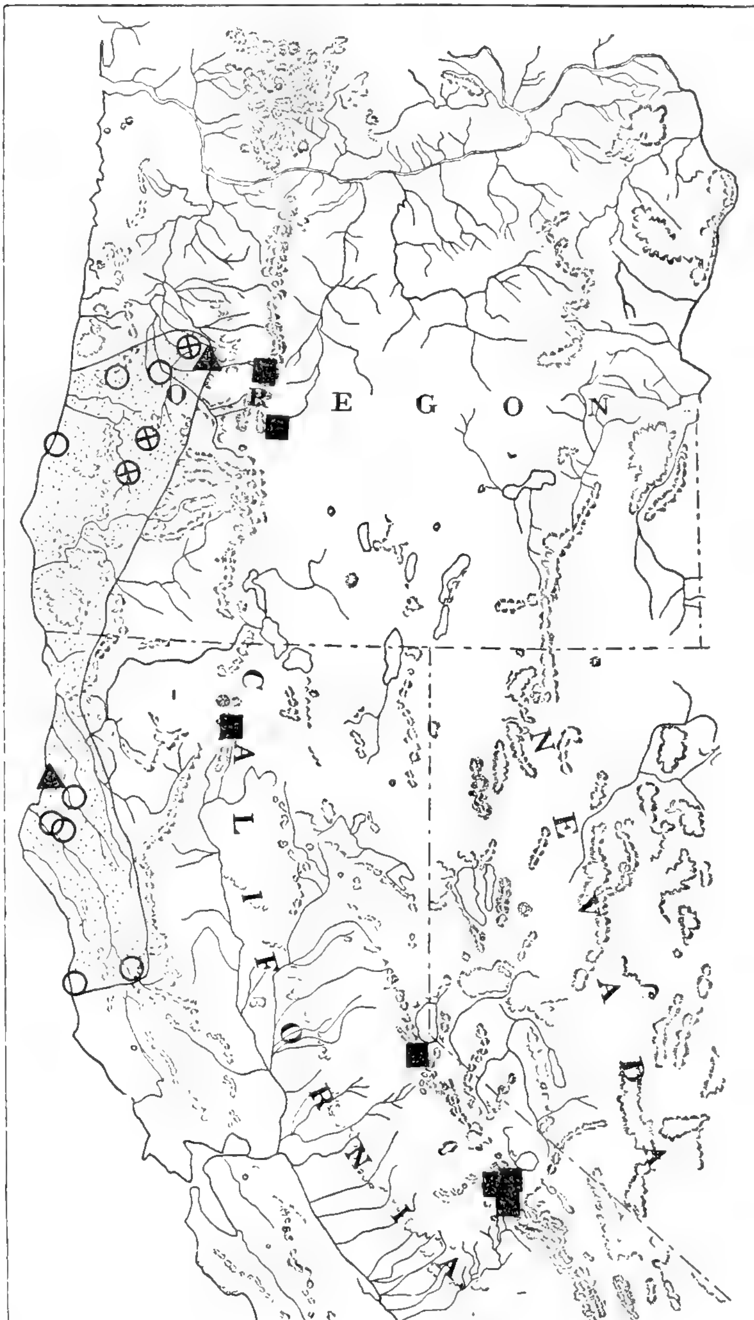

FIG. 4 (See caption on opposite page.)

to whom credit belongs for first calling the attention of scientists to the species, asserts (1891, p. 241) concerning its occurrence: "My first discovery of this animal was in June, 1886, in the valley of Elk Head, on the headwaters of Elk Creek, a tributary of the South Umpqua River, and some seven miles east of Voncalla, Douglas County [Oregon], while out looking for birds' nests . . . . I have . . . found their nests down Elk Creek, along the Coquelle River, in Coos County, in southern Douglas County, and also on the upper Willamette tributaries, in Lane County, and believe it will yet be found in Washington and perhaps through the whole of the northern coast." Maps of Oregon, which the writer has examined, show two Elk Creeks tributary to the Umpqua River. Elk Head is located on the Elk Creek tributary to the main river, not tributary to the South Fork of the Umpqua. Voncalla is spelled Yoncalla on recent maps (1908, 1910), and Coquelle is rendered Coquille on the same maps.

In the original description of *Phenacomys longicaudus* (True, 1891, pp. 303-304) there is quoted a letter from Todd in which is contained the only reference I have seen to the occurrence of the tree mouse in Curry County.

Mr. Alfred C. Shelton, field naturalist of the University of Oregon, tells me that he has located colonies in the vicinity of Mabel, Lane County, and Melrose, Douglas County; while Mr. C. I. Clay, of Eureka, California, writes that on June 16, 1915, he observed a number of *Phenacomys* nests along the road between Ferndale and Capetown, on the ridge just north of Cape Mendocino and very close to the coast.

Upon this showing it is not unlikely that the species is far more abundant and widespread than the examples now contained in museums would indicate.

II HABITS

1. GENERAL HABITAT

Characteristically, perhaps exclusively, arboreal. That the tree mouse ever comes to the ground of itself for the purpose of subserving its own specific economy remains to be demonstrated. In Todd's letter of transmittal which ac-

companied the shipment of the first specimen it is asserted that so far as could be found out, *Phenacomys longicaudus* lives exclusively among the boughs and branches of *Abies douglassi* (= *Pseudotsuga taxifolia*). Farther on Todd modifies this statement by remarking that tracks, which he thought were made by these little animals, had been seen in the snow around the trees. "They could be tracked," says Todd, "up and down the tree, but to no great distance from it, and were most likely in search of food." In a contribution to the West American Scientist (1891, p. 242) Todd again calls attention to the tracks he has seen around the trees, but specifically disclaims positive knowledge that they were made by *Phenacomys*.

Wilder gives it as his opinion that they must occasionally come to the ground, though it is to be doubted whether they spend much time there.

Clay says that in order to reach the tree containing the family nest, the males in some instances would have to descend to the ground. This is on the theory (see p. 153) that males live for at least a part of the time in small nests separate from those of the females.

All the clear evidence at hand shows that tree mice are dependent on the trees in which they live for food, home and drink. I have not seen nor can I find any record of any object found in any nest of *Phenacomys* indicating that it visits the ground. All nests at Mendocino City were found in grand firs (*Abies grandis*). The only piece of nest material not derived from this tree was a twiglet of Bishop pine (*Pinus muricata*), which was probably brought in by way of the tree branch route.

2 KINDS OF TREES INHABITED

Nests of *Phenacomys longicaudus* have been found in three conifers, *Picea sitchensis, Abies grandis* and *Pseudotsuga taxifolia.* Our field party in 1913 found nests in both the latter-named species, those at Mendocino City being in grand firs, while those at Lierly's and elsewhere were in Douglas firs.

So far as Todd was aware (1891, p. 240) the tree mouse was found only in the branches of the Douglas fir. In fact, all published records of nests which I have seen refer to their

occurrence in this tree alone. Clay reports that although the Douglas fir seems to be preferred, he has found many nests in the lowland (or grand) fir in the Mad River country (Humboldt County, California), and has taken several from the Sitka spruce. His record of nests in the Sitka spruce are so far unique.

It is quite probable that the larger numbers and general availability of the Douglas fir in the area of occurrence of the tree mouse have much to do with the observed occurrence of most of the nests in trees of that species.

3 COLONIAL TENDENCY

Although Wilder says that he has never found the *Phenacomys* in Humboldt County nesting in colonies, the experience of other investigators in other places shows that there is a pronounced grouping tendency observable. At Mendocino City, for example, our party made studies of two groups or colonies of nests, and all nests observed later exhibited a similar colonial arrangement. It should, however, be stated that in no case were the nests *closely* grouped, though they were located in the same general section of forest. Clay asserts that they live in colonies as a rule, although they spread to isolated positions in individual cases, and cover a vast expanse of territory.

One colony studied at Mendocino City was located on a flat north of town, in a grove of tall *Abies grandis* intermixed with scattering Bishop pines. The second was found on the side of a ravine a little farther to the north. Here, although the grand firs formed an almost pure stand, there were a few Douglas firs and an occasional Bishop pine. Examples of *Phenacomys* were taken in both these colonies.

Another colony was later located in large Douglas firs in an isolated position on the south-facing slope of a small hill, near the Eden Valley road, four miles north of Hearst, Mendocino County, California. A group of nests resembling those of gray squirrels, and possibly now belonging to *Phenacomys longicaudus,* was also encountered in a grove of Douglas firs about 500 feet above the South Fork of Eel River, and a mile distant therefrom, on the north side, four miles east of Hearst. Shortness of time did not permit of its examination.

Still another colony was found in the Douglas firs immediately south of Lierly's Ranch, four miles south of Mount Sanhedrin, Mendocino County, California. One tree mouse was here secured.

At Mendocino City thirteen nests were carefully examined. In eight of these animals were actually found. In the first colony there were about a dozen nests; in that on the side of the ravine, seven or eight. The colony north of Hearst contained about the same number, while at Lierly's there were more, although some of the nests observed in that locality may have belonged exclusively to *Sciurus griseus.*

4 OBSERVED MOVEMENTS

Phenacomys longicaudus does not seem to possess any extraordinary agility, quickness, or aggressiveness of movement. Wilder says the mice are quick to leave the nest when the latter is disturbed, and remarks that while sometimes they are caught in the nest they are more easily caught on the ground, where, although not really slow, they are a little clumsy. Shelton relates an instance where a tree mouse left the nest just as the observer came on a level with the structure. It ran out to the tip of a branch and was there secured by means of a shot pistol. The same observer records an instance of the frightening of a *Phenacomys* from its nest, the animal showing remarkable agility, going from tip to tip of the fir boughs with speed and ease, and so running from tree to tree until finally it escaped into the branches of an old cedar (*Thuja plicata*), the fourth tree from the nesting site. This record of remarkable agility was not borne out by our observations, according to which the animals ran rather slowly and uncertainly along the twigs on which we saw them, and seemed on the whole rather slow-moving. Several were caught with the bare hands in the trees. One tree mouse, which reached the ground, exhibited more speed there than any we saw in the trees. It is quite possible, though on this point there is no evidence, that *Phenacomys longicaudus* is strictly nocturnal and is bewildered by the light of day.

The unwillingness of the tree mice to leave the nest was quite evident. Ordinarily the occupants would remain until much of the structure had been dissected away. In one

instance an adult female and a half-grown young individual were taken from the *last double handful* of the nest-mass remaining in the tree.

The tree mice when caught did not ordinarily defend themselves with energy, although one young individual seized a finger of its captor and bit hard enough to draw blood.

5 VOICE

Wilder asserts that when individuals of *Phenacomys longicaudus* are caught they utter a mouse-like squeak. Only one of those taken by us was heard to utter a sound. This was a juvenile individual which, upon being seized, squeaked plaintively.

6 FOOD AND DRINK

At Mendocino City we always found green twigs on and in occupied nests. The leaf of a grand fir was found in the mouth of one individual, and the stomachs and intestines of all those examined were brilliant green. Microscopic examination of cross-sections of the fir needles discloses the fact that all the fleshy substance of the needle including the vascular bundles is eaten away by the tree mouse, the only portions left being the two resin ducts which traverse the entire length of each needle. These filamentous resin ducts have quite naturally been mistaken for midribs by some observers. The outer or cortical portions of young shoots are also used as food, in this case resin ducts and all being eaten. It is probable that the chief food of the species is derived from the needles and young shoots.

In a colony on Chaparral Mountain, on the slope above Maplecreek Postoffice, Humboldt County, California, which was studied by Clay, the top of practically every inhabited tree was dead. Many nests were found by locating the dead-topped trees. "The nest was sure to be there," says Clay, "and was always inhabited." In some cases in which the nest was low in the crown of the tree and far out on a limb, the bark would not be touched, but in the dead-topped trees small runway-like trails were noticed over the trunk where the bark had been stripped away. Sometimes these trails ran together making a wide exposed place. The tree was cut

always at the exact level of the nest, or the point of junction of the nest-limb with the tree. "Many trees were bushed out at the top as though they had been cut, rotted off . . . and then taken sprout; some bushing out, some forking, and some growing up in a deformed top." Examination of these disclosed furrow-like ridges in the bark, where Clay concludes the trees had been cut many years ago. Tooth marks were plainly visible in some of the more recently stripped places, so that Clay is certain the cutting is done by *Phenacomys,* though he does not know whether the bark is eaten or not.

Because of the dead tree-tops, the semi-isolated nature of the grove in which it was located, and the age of the nests, it was concluded that this colony was a very old one. It is implied, furthermore, though Clay does not permit himself to make a positive statement in this regard, that only the trees containing old nests or which had been inhabited for a long time showed the phenomena of the dead tops. The absence of dead-topped trees in the vicinity of Carlotta where nests were studied by Wilder is explained on the supposition that *Phenacomys* occupation in that neighborhood has been of comparatively short duration; and the additional suggestions are tentatively propounded, that large trees are not subject to the attacks to which the smaller ones are liable; that possibly the tree mice feed on bark only intermittently; or that it may be that the bark of older trees is not palatable. It seems that the Chaparral Mountain colony was located in small firs, while occupied trees at Carlotta are of larger size.

Although it must be admitted that the circumstantial evidence submitted by Mr. Clay is strong, still it ought to be remembered that bark damage and tree destruction by *Phenacomys longicaudus* is unconfirmed to date by any other observer, and it is possible, if not probable, that phenomena due to some other local cause or condition on Chaparral Mountain have been erroneously associated with the tree mouse.

One animal kept by Mr. Clay in captivity would not eat grain, grass, or meal, finally dying apparently for lack of proper feeding.

The area of occurrence of the tree mouse falls for the most part within the humid coast province or faunal area, a region characterized by frequent fogs, high relative humidity of the

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air, and moderately heavy rainfall. It is quite probable that the animal's need of moisture is supplied by the water which gathers on the foliage of the trees in which it lives, if, indeed, it needs more moisture than is contained in its food.

7 HOME RANGE OF THE INDIVIDUAL

The fir trees in which our party found colonies of *Phenacomys longicaudus* were close together, and transit from tree to tree by way of the foliage route would be comparatively easy. In one nest a branchlet of Bishop Pine *(Pinus muricata)* was found, as has already been noted. This could only have been brought in by the tree mouse or some other animal. It will be remembered that Shelton (see page 141 above) noted a mouse traveling from tip to tip of the fir boughs, quickly escaping in a *Thuja plicata* which was the fourth tree from the nesting site. It is not improbable that the tree mouse ranges freely through the foliage of several trees in the vicinity of his home nest tree.

8 HIBERNATION

Wilder suggests the possibility that the tree mice may hibernate in the cold region back from the coast, and records finding one in February, presumably at Carlotta, Humboldt County, California, curled up and dormant. The same day, however, he found two females with half grown young; so he concluded that the first must have been chilled into temporary inactivity by the storm just ended. Todd (1891, p. 242) suggests that the tree mice probably do not hibernate, on the basis of the tracks seen about the nest trees in the snow. But allusion has already been made to his uncertainty as to whether or not the tracks were those of *Phenacomys longicaudus.*

It is doubtful whether the cold weather is severe enough in the area of occurrence of *Phenacomys longicaudus* to make true hibernation necessary, although there may be inactivity during the colder periods. The writer has been unable to find any definite records of hibernation among the *Microti,* although Barrett-Hamilton and Hinton (1914, p. 466) refer to the inactivity during cold weather of *Microtus orcadensis sandayensis.* Bailey definitely asserts (1900, p. 6) that no American species of *Microtus* is known to hibernate.

9 STUDIES OF THE NEST

(1) Altitude above the ground

The height of nests above the ground, varying as it does from four feet to one hundred feet, testifies to the freedom of movement of *Phenacomys longicaudus* in its arboreal habitat. Wilder writes that he has found several nests low enough in the trees to be reached from the ground. Shelton records the examination of a nest a hundred feet up. In Clay's experience eight and 100 feet are the extremes, with the prevailing height at 20 to 60 feet. Nests observed by our party ranged in altitude from eight to 60 feet.

(2) Position in trees

A majority of the nests are located against or around the trunks of the trees. All those observed by Shelton in Oregon were situated next the trunk of the fir, where they were securely supported by one or more branches. Wilder asserts that in his experience most of the nests were located where several limbs join the trunk, although where nests have been found on large trees they have usually been near the ends of lower branches and at no great height above the ground.

Clay says that low nests are usually near the outer end of a drooping limb, but agrees that most nests are placed near the trunk of the tree.

All nests actually examined by our party at Mendocino City were built near the main trunk of the fir where a circlet of branches joined the tree, although we noted at least two nests on limbs several feet distant from the main trunk. In several instances the nest was built all around the trunk, so that the trunk actually traversed the center of the nest.

(3) General size

Todd (1891, p. 241) says the nests are about the size of robins' nests, or even smaller. Shelton has examined a nest only eight or ten inches in diameter, the largest nest he has seen being about two feet in diameter by one in depth. Wilder asserts that when the nests are new they are about the size of a quart measure, old nests being larger, sometimes as large as a peck measure.

According to Clay the family nests were from nine to 12 inches in diameter in new structures, up to 30 inches or more across and 12 inches or more deep, in the older ones.

Nests observed by our party varied in dimensions from about 18 inches in length, breadth, and height to three feet in diameter and two or three feet in height, enormous structures when it is remembered that the maximum total length of the mouse is only about seven and one-half inches.

(4) Skeleton, form and makeup

(a) Possible parasitism of *Phenacomys longicaudus*

All nests observed by members of the Museum party in the vicinity of Hearst and Lierly's Ranch were apparently the appropriated nests of *Sciurus griseus griseus,* many of the sticks used in their construction being too large to have been carried by the tree mice. Shelton reports that he has found, in the course of his investigations in Oregon, only one nest of original *Phenacomys* construction, all others being old and remodeled nests of the gray squirrel.

All nests examined by us at Mendocino City, however, were probably built by tree mice exclusively, since there were no sticks used which were too large to be handled by them alone.

An interesting question arises as to the occupation of the gray squirrel's nests by *Phenacomys.* Does the tree mouse parasitize and finally drive out his larger arboreal neighbor, or does the mouse appropriate the nest only after its abandonment by the gray squirrel?

(b) Form and composition of the nests

Although one's first impression of those nests studied at Mendocino City was that they were loosely built, it was soon discovered that they were steadily fastened and rather difficult to dissect. Usually the structure was spherical in form with a slight flattening on top. Often the flattening was so pronounced as to make the nest hemispherical in form. The skeleton of the nests was formed entirely from twigs of the grand fir *(Abies grandis).* As used in the nest mass these twigs were dry and leafless. Making up a close interpacking was much material composed of the net-like fibrous mat of the net lichen, *Ramalina reticulata,* and of the resin ducts of fir leaves, the latter material predominating. Piled up above the thick mass of the main nest there was always a loose superstructure of twigs and branchlets. Some of these were of considerable size for the small mouse, the largest being one-eighth inch in diameter and four to eight inches long.

Residents told us that green twigs on the ground beneath the fir trees indicated not only the presence of a *Phenacomys* nest but also the fact that the nest was occupied. Although this would not seem always to be so, since we found green twigs under trees in which there were no nests, it would appear to be the rule. At any rate, green branchlets were noted on the ground under most of the occupied nests we investigated; and it was true in all instances where the nest was occupied that fresh green fir branchlets were pulled into the loose superstructure of dry twigs on top of the nest.

Reference has already been made to the fact that the nests found at Lierly's Ranch and Hearst, Mendocino County, were made up of sticks too large to be transported by *Phenacomys,* so doubtless originally constructed by the gray squirrel *(Sciurus griseus griseus)* or the wood rat *(Neotoma fuscipes fuscipes).* The lone individual tree mouse taken at Lierly's Ranch was found 50 feet up in a Douglas fir, in a nest 18 inches in diameter, built of sticks of fir and lined with "tree moss" (really the net lichen, *Ramalina reticulata)* which appeared to have been fluffed up by the occupants.

Our studies of nests at Mendocino City showed that below the level of the used portion of the nest there was usually found a mass of decaying matter, sweating and steaming like a pile of old manure or like green feed in a silo, a very large part of the nest being made up of this material. In composition this mass was nothing more than the resin ducts of fir leaves and net lichen with quantities of feces distributed through it. Occasionally, but not often, this old slowly decaying matter was relatively dry.

Well defined galleries traversed the nests in various directions, providing ready communication between the inner nest cavity and the outer world. When the nest was built all the way around the trunk of the tree a circular gallery, running around the trunk and communicating with runways leading to the nest cavity and the exterior, was usually found.

Bailey (1915, pp. 148-149) says some *Phenacomys* houses had only one nest [inner nest cavity], and others had as many as five. Concerning one nest examined by him he says: "The twigs of which it was largely composed had settled in a half decayed and earthy mass as solid as a muskrat's house, and

beginning at the top a tiny burrow wound down spirally through the structure to one after another of the four or five fresh, clean little nests of green spruce leaf fibers."

Shelton has described several nests studied by him in the vicinity of Eugene, Oregon. One nest, found approximately 100 feet above the ground in a Douglas fir on Spencer Butte, seven miles south of Eugene, was about two feet in diameter by one in depth. It was composed of dry twigs and moss and was beyond all doubt the nest of a gray squirrel *(Sciurus griseus)* remodeled for *Phenacomys* use. The exterior of the nest was wet and mouldy, but the interior was dry and warm. The inner nest was spherical in shape, about five inches in diameter, and composed of fir needle fibers. The nest cavity was within this ball-like structure, and communicated with the outside through a small round opening about an inch in diameter in the wall of the inner nest. A mouse, after traversing this opening, would find itself in the coarse outer structure of dry twigs and moss, through which escape was possible in any direction.

Another nest, found in February by Bovard and Shelton, was located 30 feet up in a Douglas fir. This was a large nest, doubtless originally belonging to a gray squirrel. Its coarse outer structure was of large dry twigs and moss. Within was a large quantity of fibrous material, apparently from the inner bark of the tree, and within this was the inner nest proper, a round ball of the characteristic shredded fibers of the fir leaves. The outer structure was wet and mouldy, and the entire nest was heaped high with piles of rotting feces. In this nest there were taken two young animals, half or two-thirds grown. In the course of the investigation, the nest was entirely dissected away, and there remained nothing of it. Returning to the same locality in June, another nest was found in practically the same crotch. This was a small nest, only eight or 10 inches in diameter, composed of soft moss and the fibers of the fir needles. A small quantity of feces had collected. As Shelton remarks, the indications are that the adult mice, returning and finding their home destroyed, had started a new one of their own construction. Incidentally it should be remarked that this was the only instance noted by Shelton of a nest of original *Phenacomys* construction.

Wilder writes that he has found mud-masses in some of the nests, and that the foundation of a fresh nest recently examined by him was of small dry branches and mud balls. In mentioning these facts, he suggests that possibly the nests containing mud are built upon structures started by some mud-mason like the robin, or possibly a wood rat, which makes use of anything loose it can find.

More extended reference is made below (see page 153) to the possibility of the existence of two kinds of nests, "male" nests and "family" nests. Clay has submitted the following description of the supposed nest of the male: "The male nest is a neat, compact, round ball of small twigs, five to eight inches in diameter or possibly a little larger, well lined with the usual material, containing one entrance hole as a rule, the opening facing the trunk of the tree and usually being well hidden by foliage. The favorite location is one where the fir needles are thickest on the limb, some distance away from the trunk of the tree. Annual additions were not in evidence in any of the male nests examined. Ordinarily only one nest is to be found in a tree, but in several instances in which the family tree was isolated the male's nest was found in the same tree with the family nest. The nest of the male is always higher in the tree than the family nest, and is usually well concealed."

(c) The inner nest cavity

All inner nest cavities examined by us were lined either with net lichen or with the fine fir-leaf resin ducts. In spite of the humidity of the surroundings and the dank character of the nest mass below it, this inner nest appeared to be dry and comfortable. The finely shredded character of the material used for the inner nest guarantees its softness, and the thickness of its walls probably insures a certain degree of heat in occupied nests. It is even possible that the slow oxidation of the nest-mass, as indicated by the sweating nature of the material beneath the occupied nest cavity, is a source of heat.

The cavity of the nest at Lierly's Ranch from which the tree mouse was secured was 10 inches across. It was always necessary to dissect away much outer material before the inner nest could be found. Located in the upper part of the nest as a whole, it was in all cases covered over and well protected from the outside.

Residents of Mendocino City said the tree mice lined their nests with hair, but this we failed to confirm.

As remarked above, feces were found in quantity throughout the entire nest structure, except in the inner nest cavities, although a few feces are present in a mass of inner nest cavity material which was saved and brought to the Museum.

Even this much of a localization in the deposition of excrement is interesting, as it seems to indicate an early stage in the development of an instinct of sanitation.

(5) Large nests the work of years

Observations have already been made concerning the extremes of size displayed by different nests. For example, Todd records noting a structure the size of a robin's nest (1891, p. 241), or even smaller (in True, 1891, p. 304). Our party observed nests which were as much as two or three feet in height and three feet in transverse diameter. A significant point regarding these larger nests is that only their upper portions were in use.

Clay reports that the family nests showed signs of being renewed at least annually and possibly at even more frequent intervals. Deserted beds were found under or alongside those which were occupied. The type of branching at the point where the nest was located was a most important factor in determining the form of the nest. Some nests were built wide; in these the deserted inner cavities would be on a level with the occupied one. Others were built high rather than wide; in these the deserted beds would be superimposed one above the other. It seems clear that each nest becomes larger year by year. Apparently the discarded resin ducts of the fir leaves with the twigs remaining after the tree mouse has eaten off the fleshy portions of the leaves are immediately incorporated into the nest mass. This, in itself, would cause a continuous increase in size. Whether there is a new nest actually built on top of the old mass every year is unknown, but it is not improbable that some such regular addition is constructed.

(6) Desertion of nests

Under this head Todd (1891, p. 241) says: "For some reason which I have not been able to discover, these nests seem to be frequently changed or deserted, from the fact that

we frequently find in the woods and under lone trees of this variety, on the ground, small parts and at times almost, as it appears, the entire nest." Wilder says that the tree mouse seems to desert nests which have been disturbed, and has found a few nests apparently permanently unoccupied. Nearly all the nests examined by our party at Lierly's Ranch and at Hearst were apparently deserted or unoccupied. Animals were actually taken in eight out of 13 nests we carefully investigated at Mendocino City. Of the five nests we found to be unoccupied, some were doubtless deserted, while the dwellers in the others may have been out at the time of our visits.

Wilder has often noticed the disappearance of entire nests previously located. This together with Todd's record of finding portions of nests on the ground clearly indicates the presence of enemies of the tree mouse. Doubtless the small boy is at present the chief of these. Although there is nothing definite on this head Mr. Wilder suggests cats and horned owls as possible additional enemies. There is a possibility also that unusual gales of wind may occasionally dislodge the nests.

10 BREEDING HABITS AND FAMILY RELATIONS

(1) Time of breeding and size of families

On July 15 and 17 we found young in three nests at Mendocino City. In each of two cases, there were two young, in one case a single individual. Shelton took two young from a nest at Spencer Butte, near Eugene, Oregon, on February 21. Wilder found a female and two half grown young in Humboldt County, California, during the same month, and asserts that the tree mice seem to breed all through the spring and summer. Clay opened four nests containing three young each, and says the breeding season seems to occur from the middle of April till late in the summer.

It may be that, like some species of *Microtus,* the young may be born at any season, but it is perhaps more probable that their birth is limited to late winter, spring and summer. Two pairs of abdominal mammæ are borne by the females, which indicates that litters are small.

The young are evidently helpless for some days after being born, remaining for the time in the inner nest cavity. Young in three out of the four nests investigated by Clay had not yet opened their eyes.

(2) Preponderance of females

Of all the sexed specimens of *Phenacomys* available 10 are males and 20 females. This preponderance of the females in series of *longicaudus* is impressive, and the question immediately arises, why should there be such a discrepancy in numbers of the sexes?

Segregating the specimens according to age, we find that of the eight adults, their age being determined on the basis of the degree of emergence of their cheek teeth, only two are males.

Twelve specimens of *Phenacomys orophilus* are equally divided between the sexes, there being six of each. Of four fully adult *orophilus*, one is a female and three males.

There are at least two possibilities to be considered: (1) that the mice are polygamous or promiscuous, and that there are actually more females than males; (2) that the female adults remain more closely in the nests than the males do, and are taken in greater numbers by our methods of capture, which involved the dissection of the nests.

It may be that both these possibilities are effective. Of the eight youngest examples at hand six are males and two females, but of all the young of *longicaudus* available, eliminating four alcoholics not sexed, eight are males and thirteen females. It appears that among the young individuals the proportion of females to males is well below two to one, while among the adults the proportion is four to one.* If males and females are born in equal numbers the young, supposedly non-breeding individuals, should have divided up equally between the sexes. But since they did not, one is tempted to the conclusion that females are actually about twice as numerous as males.

On the other hand, the difference in proportions of females to males in the series of young and adults respectively seems to indicate that the females do remain more closely in the nests than the males and so were taken in greater numbers by the methods of capture employed.

Orophilus and *albipes*, being taken by free trapping on the ground, would probably not give the bias in the number of

*The classification of the specimens into adult and young is an arbitrary one, and several of the examples classed as young probably are breeders.

females that the dissection of the nest would. In fact, since the males may be more active as foragers than the females, there might even be a disproportion of males.

(3) Family relations

In each nest in which young were discovered there was one inner nest cavity and one brood of young. This would seem to indicate that only one family lives in each occupied nest. Possible evidence to the contrary was the capture of two seemingly adult males in a tree in which a nest was being dissected. It is not certain, however, that both these mice came from this nest.

Wilder says that he has several times found the female and young in a large nest, and the male in a small nest a few feet higher in the same tree. After remarking upon the difficulty he has had in finding males he suggests that it is possible they live in nests separate from those of the females, in the large trees, where their small nests would not be noticed, while the females for the most part select smaller trees.

Clay asserts that the male and female of a family do not live in the same nest during the rearing of the young, although it is probable that the males do seek the family nest thereafter. The small nest of the males would be likely, says he, to be destroyed by storms, necessitating the building of a new nest each season. On January 6, 1912, two adults were found in one nest, the one secured being a female. Clay suggests that the "escape" was a male, and that the incident would support the theory that the male and female live together during the winter months.

This most interesting suggestion of Wilder and Clay deserves further investigation. If it is in accord with the facts, there would be furnished an additional reason for the preponderance of females in our series; for the large family nests would be much more likely to be dissected than the small nests of the males. It seems to the writer that the evidence on this point of the separate nests for the sexes is inconclusive.

E THE POSSIBLE ANCESTRY OF *PHENACOMYS LONGICAUDUS* TRUE

The known characters and distribution of the members of the genus would seem to support the theory that the subgenus *Arborimus* is derived from the subgenus *Phenacomys,* or that both subgenera are derived from a common ancestral stock not very different from either; and that the isolation of portions of the parent stock was an important factor in their differentiation.

It is furthermore possible if not probable that both *Phenacomys longicaudus* and *Phenacomys albipes* are descended from the same species, doubtless a member of the subgenus *Phenacomys.* Compared with *albipes, longicaudus* would seem to be a little more specialized. The two species may exemplify successive migrations of similar individuals from a common center, *longicaudus* being of the first wave, *albipes* of the second. *Longicaudus* would in this way have had time to become more specialized than *albipes.*

It is almost impossible to avoid the inference that the long tail in *Phenacomys longicaudus* and the arboreal habit are in some way associated.

Allen has recently shown (Bull. Amer. Mus. Nat. Hist., *34*, 1915, p. 166) that the tail in different groups of tree squirrels is developed in proportion to their exclusiveness as tree dwellers, the ratio of tail length to total length varying in the different groups from about 40 to 52 per cent. Ground-living species of *Phenacomys* (except *albipes*) have ratios of 25 per cent, *albipes* (ground living) has an average ratio of 38 per cent, and *longicaudus* (tree dwelling) of approximately 40 per cent.

As implied above, it seems certain, from the close general similarity between the tree mouse and its ground living relatives, that the long-tailed arboreal species is derived from some short-tailed terrestrial form.

The possible connection between the long tail of *P. longicaudus* and its arboreal habitat suggests a train of puzzling questions.

Did *P. longicaudus* acquire its long tail and then take to the trees? Or did it take to the trees and then gradually

acquire its long tail? If it got its long tail while still living on the ground, taking to the trees when the tail reached approximately its present length, why has not *P. albipes,* which has a tail nearly as long, also adopted an arboreal habitat? If *Phenacomys longicaudus* took to tree life while still short-tailed, acquiring its long appendage thereafter through some form of environmental or other pressure associated with arboreal life, how is the acquisition of a long tail by the wholly ground-living *P. albipes* to be explained?

But in this connection it ought to be remembered that, in view of the small number of specimens of the latter species which have been taken, and of our ignorance concerning its life history, we are hardly in a position to state positively just where its habitat does lie.

Perhaps the ancestor of both *longicaudus* and *albipes* was long-tailed and is extinct and unknown. In this case possibly *longicaudus* merely selected the arboreal habitat for which its characters already fitted it. There remains the problem of why the similar *albipes,* which is to all appearances equally well fitted for tree life, did not also become a tree mouse.

If *longicaudus* and *albipes* represent successive waves of migration, perhaps *longicaudus* may be conceived to have attained to the arboreal environment before the development of *albipes.* If this were so the prior occupancy of the tree habitat by *longicaudus* would possibly be sufficient to account for the terrestrial predilections of *albipes.*

It should here be noted that if the hypothesis is true, that *Phenacomys longicaudus* is derived from some ground-living microtine, we have presented in the phylogeny of the tree mouse an unusual type of migration. The writer has already emphasized (The status of the beavers of western North America, Univ. Calif. Publ. Zool., vol. 12, in press) that in general each group of mammals occupies the same ecologic niche in different places rather than different ecologic niches in the same place. The *Microtinæ* are characteristically terrestrial, with some members adapted to a more or less aquatic, and others to a more or less fossorial, mode of life. Apparently the stock which we now know as *Phenacomys longicaudus,* in the course of its phylogeny, has broken away from the time-honored group niche in which all other members of its subfamily

are found, and has come to occupy a niche entirely different. It has performed not only the usual geographic migration, but also the comparatively rare ecological migration.

F SUMMARY

1. For 22 years subsequent to its discovery the microtine rodent *Phenacomys longicaudus* True was represented in natural history museums by but three specimens. There have been recent accessions of notes and specimens which permit of substantial contributions to knowledge of its systematic and ecologic status.

2. Habits and associational relations are just as much a part of the animal as its physical characters. In the interest of adequacy and comprehensiveness, emphasis upon study in these fields should and probably will become more insistent as time goes on.

3. *Phenacomys longicaudus* is the type of *Arborimus,* a new subgenus of *Phenacomys.* The most striking characters of the type are its cinnamon reddish dorsal coloration, its long tail, and its arboreal habitat.

4. *Phenacomys albipes* Merriam is tentatively referred to the new subgenus, though it is intermediate in certain characters between *Arborimus* and *Phenacomys,* and differs from *P. longicaudus* in several important particulars.

5. The subgenus *Arborimus* is restricted to the humid coast belt of western North America, specimens having been taken in southwestern Oregon and northwestern California only.

6. All the clear evidence at hand indicates that the tree mouse is dependent on the trees in which it lives for food, drink and shelter.

7. The tree mouse has been found nesting in the Sitka spruce *(Picea sitchensis),* the grand fir or lowland fir *(Abies grandis),* and the Douglas fir *(Pseudotsuga taxifolia).*

8. Ordinarily the nests are found in groups, so that it is proper to refer to the animal as loosely colonial.

9. Our experience with *Phenacomys longicaudus* did not show it to possess any extraordinary agility, quickness, or aggressiveness.

10. The tree mouse, from all evidence, feeds principally

on the fleshy portions of the fir needles and the cortical portions of young fir shoots, leaving the resin ducts and stripped shoots to be incorporated into the nest structure.

11. It seems probable that each individual tree mouse ranges freely through the foliage of several trees in the vicinity of its home nest-tree.

12. Probably *Phenacomys* does not hibernate, though it may become less active or altogether inactive during the coldest weather.

13. The nests vary much in size and in altitude above the ground. A majority are built against or near the trunks of the trees. In some localities old gray squirrel nests have been occupied by the tree mice. All nests examined at Mendocino City were apparently of original *Phenacomys* construction. Twigs, branchlets, resin ducts of fir leaves, and net lichen *(Ramalina reticulata)* were the chief materials used. The inner nest cavity was of soft material, either the resin ducts of fir leaves or tree moss. The nests increase in size with age; whether the increment is due to gradual accumulation of material or to annual additions at some particular season is unknown. Some of the nests seem to have been deserted.

14. Young have been found in the nest in February and in July. Numbers of young actually taken were three per family in four instances, two per family in four additional instances, and one in a single case.

15. The number of females in our collections is disproportionally large. It is possible that females are actually more numerous than males, and also that our methods of capture, involving the destruction of nests, have resulted in a larger number of females being taken.

16. Apparently only one family occupies a nest.

17. There is evidence which seems to show that males live in nests separate from those of the females for at least a part of the year, the male nests being smaller and different in other respects from the family nests; but the data are as yet incomplete and inconclusive.

18. Probably *Phenacomys longicaudus* and *P. albipes* are derived from the same species, doubtless a member, past or present, of the subgenus *Phenacomys*. Several interesting questions regarding the characters of *longicaudus* and *albipes* and their relation to habits and environment await answer.

G LIST OF WORKS CONTAINING IMPORTANT MATERIAL RELATIVE TO THE GENUS *PHENACOMYS*

ALLEN, J. A.

1894. Descriptions of ten new North American mammals, and remarks on others. Bull. Amer. Mus. Nat. Hist., *6*, 331-332.
   Original description of *P. truei (=P. orophilus)*.

1894. Recent progress in the study of North American mammals. Author's ed., extracted from Abstract Proc. Linn. Soc. New York for year ending March 27, 1894, pp. 1-29 (17 to 45 in original form).
   Notes description of genus *Phenacomys* by C. H. Merriam, and lists six forms; contains note on origin and distribution (p. 15 = p. 31 original).

1899. On mammals from the Northwest Territory collected by Mr. A. J. Stone. Bull. Amer. Mus. Nat. Hist., *12*, 1-9.
   Original description of *P. constablei* (p. 4).

ANDERSON, E. M.

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   Record of capture of *P. orophilus* at Schoonover Mountain (Okanagan Falls), British Columbia (p. 20).

BAILEY, V.

1915. Discovery of the tree mouse (*Phenacomys longicaudus* True). Oregon Sportsman, *3*, 147-149.
   Valuable article on habits.

BANGS, O.

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BARRETT-HAMILTON, G. E. H., and HINTON, M. A. C.

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   Fossil material erroneously referred to *Phenacomys* by Nehring disposed in the genus *Mimomys* Forsyth Major (p. 473 footnote).

CARY, M.

1911. A biological survey of Colorado. U. S. Dept. Agric., Bureau Biol. Survey, N. Amer. Fauna, *33*, 256 pp., 12 pls., 39 figs. in text.
   Lists two species of *Phenacomys* from Colorado, giving full treatment to each (pp. 119-120).

ELLIOT, D. G.

1899a. Preliminary descriptions of new rodents from the Olympic Mountains. Field Columb. Mus., Zool. Ser., *1*, 225-226.
   Original description of *P. olympicus*.

1899b. Catalogue of mammals from the Olympic Mountains, Washington, with descriptions of new species. Field Columb. Mus., Zool. Ser., *1*, 239-276, pls. XLI-LXI, unnumb. figs. in text.
   Habitat, characters, and abundance of *P. olympicus* (p. 255).

1901. A synopsis of the mammals of North America and the adjacent seas. Field Columb. Mus., Zool. Ser., *2*, xiv + 471, 49 pls., 94 figs. in text.
Seven species of *Phenacomys* listed from North America (pp. 167-169).

1905. A check-list of mammals of the North American continent, the West Indies and the neighboring seas. Field Columb. Mus., Zool. Ser., *6*, v + 761, frontispiece.
Recognizes ten forms of *Phenacomys* (pp. 226-228).

1907. A catalogue of the collection of mammals in the Field Columbian Museum. Field Columb. Mus., Zool. Ser., *8*, viii + 694, 92 figs. in text.
Specimens of the following are in Museum: *P. orophilus, P. olympicus* (p. 282).

FLOWER, W. H., and LYDEKKER, R.

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HOLLISTER, N.

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Treats *P. intermedius;* suggests that *P. orophilus* is identical with or only slightly differentiated from *P. intermedius* (pp. 20-21).

JEWETT, S. G.

1915. Discovery of a rare rodent. Oregon Sportsman, *3*, 37-38.
Record of capture of second known specimen of *P. albipes* on McKenzie River, Lane County, Oregon.

LYDEKKER, R.

1896. A geographical history of mammals. (Cambridge, University Press) xxi + 400, map, 82 figs. in text.
Three-line general reference to genus *Phenacomys* (p. 342).

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Types of six described species of *Phenacomys* are in the government collections (pp. 96, 97).

MERRIAM, C. H.

1889. Description of a new genus *(Phenacomys)* and four new species of Arvicolinæ. U. S. Dept. Agric., Div. Ornith. and Mamm., N. Amer. Fauna, *2*, 27-35, 5 pls., 3 figs. in text.
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Original description of *P. orophilus* (pp. 65, 66).

1892. The geographic distribution of life in North America with special reference to the Mammalia. Proc. Biol. Soc. Wash., *7*, 1-64.
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Original description of *P. preblei*.

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1901. Two new rodents from northwestern California. Proc. Biol. Soc. Wash., *14*, 125-126.
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MILLER, G. S., JR., and REHN, J. A. G.

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Preble, E. A.

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Stephens, F.

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Warren, E. R.

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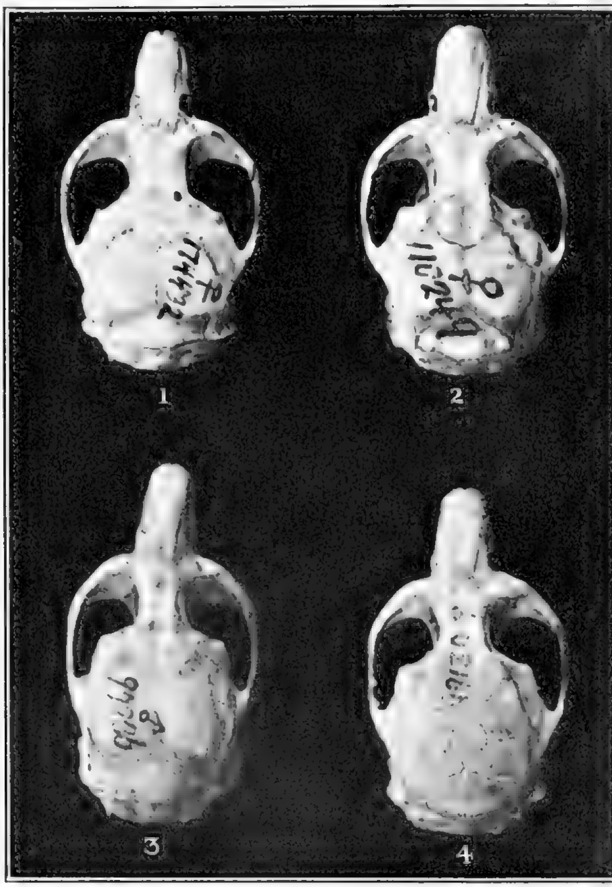

DORSAL VIEW OF CRANIA OF *PHENACOMYS*

No. 1, *Phenacomys (Phenacomys) intermedius;* No. 2, *Phenacomys (Phenacomys) orophilus;* No. 3, *Phenacomys (Arborimus) albipes;* No. 4, *Phenacomys (Arborimus) longicaudus.* About twice natural size

Note the narrower interorbital constriction in *Arborimus:* the length and narrowness of the cranium of *albipes*, as well as the length of its brain case; and the general similarity in cranial outline obtaining between the two subgenera, shown particularly well in the comparison of *longicaudus* with *intermedius* and *orophilus*

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VI

TERTIARY DEPOSITS OF NORTHEASTERN MEXICO

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December 31, 1915.

INTRODUCTION

In connection with the examination of the artesian water conditions of Northeastern Mexico, and the search for oil deposits in the same region, a considerable amount of geological investigation has been necessary. The field work with which the writer has been directly connected was carried on principally by Prof. W. F. Cummins, assisted by Mr. J. M. Sands. Mr. W. Kennedy also spent some time on more detailed work along the Rio Grande and in making special sections. In order that the information thus obtained may be of service to other workers in this same field, the following generalized statement has been prepared from their various reports and collections and from personal knowledge of the deposits.

It must be remembered that the work has largely been of the nature of a reconnaissance and that it has been done with a total lack of topographic maps and in part even without those giving accurate geographic detail, since these were not available until after the field work was completed. It is also to be regretted that while large collections of fossils were made during the progress of the work, only a small part of these were accessible for use in preparation of the present paper.

THE AREA

Lying to the east of that portion of the main body of the mountainous highlands or Cordilleras of Mexico known as the Sierra Madre Oriental, which, beginning at the Sierra Carmen on the Rio Grande border, extends southeastwardly by way of Monterey and Tamasopa, there is a broad valley, interrupted in many parts by hills. This valley in turn is bordered on the east by disconnected ranges and groups of hills, which, as a whole, are roughly parallel to the main range and to the course of the Rio Grande. Among these groups and ranges may be named the San Antonio, San Juan, Vallecillo, Picachos, Papagallos, San Carlos and Tamaulipas. Prof. Cummins has proposed that these be known collectively as the Tamaulipas Range, which is seemingly warranted by the common origin of the groups.

This range consists of deposits of shales and limestones of late Cretaceous age, more or less altered and disturbed by igneous activity and by folding, and as the trend of the coast in this region is a little west of south, the southeast course of the Tamaulipas Range brings it rapidly nearer the Gulf until, in the region around Tordo Bay, fifty miles north of Tampico, the hills of this range are within ten miles of the coast and scattered peaks and ridges of later eruptives occur within four miles or less of the Gulf shore.

In the triangle thus formed by the Rio Grande, theTamaulipas Range and the coast line we find the occurrence of Tertiary deposits which are the direct continuation of those of the Texas area, but the Tertiary beds, which, along the Rio Grande, form the surface rocks for a distance of 150 miles, narrow rapidly toward the south, the lower beds disappearing in turn by reason of successive overlaps of the later, until, at the southern end, on the Zarzizal River, just north of Tordo Bay, the entire exposure shows no Tertiary beds below the Oligocene, which has here a width of a very few miles.

The Tamaulipas Range thus marks the extreme western and southern limits of these beds and, so far as our investigations go, this area contains the last appearance in Mexico of the Eocene beds as known in Texas, since the beds of this age which are found south of the Tamaulipas Range have a fauna more nearly related to those of the deposits of the Pacific Coast.

PHYSIOGRAPHY

The structure of this coastal area is largely that of a monoclinal plain with local foldings which are, however, of very slight extent, except in close proximity to the western boundary. Within it there are comparatively few exposures of igneous rocks and these are confined to its southern portion, and, as a whole, it corresponds closely in its topographic features with the southwestern Texas region. The gentle slope of the land immediately adjacent to the Gulf shore, which has such a broad development in the Texas coast prairies, here rapidly narrows toward the south. In the more elevated region directly west of it are exposed the calcareous materials and conglomerates which were first described from Reynosa on the Rio Grande and named for that place. These beds, which may be correlated with the Lafayette formation of the Pliocene, not only form the surface rocks of the area lying east of that in which the lower Tertiaries are now exposed, but judging from the numerous residuals occurring over the entire area and even in the Tamaulipas Range itself, seem, when originally laid down, to have formed a mantle over it all. Indeed, this formation, either by its actual presence or by the wide distribution of the detritus from it in the territory from which it has been denuded, masks and covers the underlying beds to such an extent as to render it difficult, if not impossible at many places, to determine their age or even their character.

Taken as a whole, the area occupied by the lower Tertiaries is one of rather low relief as compared with the territory west of it and hills of any considerable height above the general level of the country are rather few and principally confined to the western portion. They are practically all the result of erosive action. In the northwestern portion of the area there are long ranges of these hills extending from Amole Creek to the Salado River which are known as the Ceja del Macha and Ceja Madre and are made up of clays and hard Tertiary sandstones. To the south similar but lesser ranges and isolated hills occur which owe their existence to other sandstones and clays of the same or later horizons. To this class also belong the hills east of Cerralvo, the Sierra Colorado northeast of Ramones, Loma Alta and

Sierra Larga in the valley of the Salinas River near Herreras, and other similar hills along the western margin of the area as far south as the Conchos River.

The Sierra de Pomeranes, east of Mendez on the Conchos, while composed principally of sediments of middle or upper Eocene age and largely due to erosive action, seem to be connected also with the Corcovado uplift and mark the beginning of the influence of such orogenic movements. These become more and more manifest toward the south as shown in the Martines hills east of Abasolo and in the San Jose de las Rusias hills, where igneous rocks make their appearance breaking through the sediments of the upper Oligocene. The northern half of the area is drained by affluents of the Rio Grande. The most northerly streams of interest are the arroyos de Caballero and del Amole, a few miles south of Guerero. Following these the Salado River, which drains the Sabinas and Esperanza coal fields, crosses this belt and empties into the Rio Grande opposite Zapata. The principal branch of this river on the south is the Sabinas. South of these, the Salinas River (also called the Pesqueria) coming in from the region just north of Monterey, joins the San Juan near Aldamos. The San Juan itself, which drains the area south of Monterey, flows northeastward and reaches the Rio Grande at Carmargo. South of the Rio Grande the only two important river systems are the Conchos and the Soto la Marina. The Conchos heads west of Linares and, flowing north of the San Carlos and Burgos groups of mountains, reaches the gulf by way of Mendez and San Fernando, while the Soto la Marina, rising just southward of Linares, flows southeastward by way of Abasola and Soto la Marina, passes between the Sierras de Martines and Tamaulipas and then turns eastward to the gulf. In its lower reaches the Conchos River is sometimes called the Presas. Between these two rivers is the arroyo Chorreras and south of them the Zarzizal, which empties into Tordo Bay.

CRETACEOUS FLOOR

The deposits of Cretaceous age which appear in this area in connection with the Tertiary are: The Escondido Beds, the Papagallos Shales and the San Juan Limestones.

ESCONDIDO BEDS

These beds as described from the Rio Grande section[1] comprise the materials lying between the top of the Coal Series (that division of the Taylor marls which contains the coal deposits of Eagle Pass, Fuente, Sabinas, Esperanza, etc.), and the basal Tertiary and consist of alterations of clays and sands, more or less glauconitic, with an abundant and characteristic fauna, which is as yet only partially described. *Sphenodiscus pleurisepta* Con., and *Ostrea cortex* Con., are probably the most abundant species in it, although it also carries a large gasteropod fauna, including *Buccinopsis parryi* Con., *Volutomorpha texana* Con.

On the Rio Grande the rocks of this formation extend from Eagle Pass to the mouth of Caballero Creek, where we found its contact with the Midway, or basal Eocene. This contact was traced southward as far as the Rancho del Pescado, a few miles southwest of the Laguna de la Leche, where we found the last exposure of the clays with *Ostrea cortex*. It is probable that the brown clays and shales occurring on the Salado River and tributaries north of Rodriguez, may belong to the Escondido, but we found no fossils that would enable us to place them there with certainty, nor were we able to recognize them farther south.

The Escondido is the latest Cretaceous known in the Texas area. In its lower part it carries *Exogyra costata*, but this is absent from its upper beds. Stephenson says of it:[2]

"In this connection it should be stated that the Rancocas and Manasquan formations of New Jersey, which carry only a meager fauna, are thought to be somewhat younger than the *Exogyra costata* zone, and the upper part of the Escondido formation of southwestern Texas may be a little younger

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[1] Dumble, E. T., Notes of the Geology of the Valley of the Middle Rio Grande, Bull. Geol. Soc. of A., Vol. 3, p. 227, 1892.

[2] Stephenson, L. W., "Cretaceous-Eocene Contact," U. S. G. S. Prof. Paper 90-J, p. 157, 1915.

than that zone, although its fauna is composed of strictly Mesozoic types, of which the genus *Sphenodiscus* is the most striking example."

Papagallos Shale

To the west of the final exposure of the Escondido beds near the Pescado Ranch and apparently dipping under them, there is a series of very fine-grained blue or black limy clay shales, weathering brown, yellow or white, in which we have so far found no fossils. These shales carry both selenite and barite and weather into slaty particles. These shales were first studied by us in the Papagallos Hills west of Ramones and we have given them this name. The Papagallos shales are exposed along the western border of this area from the San Antonio Range, on the north, nearly to Tordo Bay and are also found over extensive areas south and west of the Tamaulipas Range. They overlie the gray limestone of the San Juan and have a very considerable thickness.

San Juan Limestone

Exposures in various canyons of the Tamaulipas Range show, underlying the Papagallos shales, a series of thin to medium bedded gray limestones with Inocerami and Ammonites. The fossils so far found are not very well preserved, but the Ammonites seem to fix the age as equivalent to the Taylor or Austin beds of the Texas Cretaceous. In a few places the Tertiary beds overlap the Papagallos and rest directly upon these limestones.

South and west of the Tamaulipas Range the Papagallos shales and San Juan limestones occupy a very large area, overlie the Tamasopa limestone, which is the top of the Middle Cretaceous, and represent the entire series of Upper Cretaceous beds of the Mexican geologists as known here.

The exact correlation of these beds with those of the Texas section is not yet possible, as they represent an entirely different phase of deposition and carry so few fossils.

The upper Tamasopa limestone around Micos is correlated by Bose[3] with the Woodbine or Timber Creek beds of the Upper Cretaceous of Texas, which is probably of the same age as the Dakota of the interior region.

[3] Bose, E., "Neue Beitrage zur Kentniss der Mex. Kreide," p. 10, 1910.

Around Cardenas, which is on the table-land east of San Luis Potosi, overlying the Tamasopa limestones there are highly fossiliferous beds which apparently represent the Eagle Ford, Austin and part of the Taylor, as these formations exist along the Rio Grande southeast of Del Rio.

In the Coastal plain of Mexico, east of the Cordillera, the place of these fossiliferous beds is occupied, as has been stated, by the San Juan and the non-fossiliferous Papagallos, and these two formations stretch northward to the Salado River beyond which we find again the fossiliferous beds of the Upper Cretaceous. They, therefore, in all probability either represent the deeper sea deposition of which the fossiliferous beds were more nearly littoral or indicate the existence of a barrier of some description in this vicinity during the later period of the Upper Cretaceous. The evidence seems to favor the latter condition and that at the close of the Cretaceous this barrier was extended to the southeast by an uplift or uplifts which formed the series of mountain groups and ranges here referred to as the Tamaulipas Range.

On the Rio Grande there appears to be only a slight angular unconformity between the Cretaceous and the Tertiary, but, going southward, we observe that the disturbances at the close of the Cretaceous folded and flexed the limestones and shales so that the contacts from Rodriguez south show very decided unconformities.

CRETACEOUS-TERTIARY CONTACT

The contact between the Cretaceous and the Eocene which, beginning south of San Antonio, Texas, runs a little south of west to the southwestern portion of Uvalde County, makes an abrupt turn at that point and then runs almost due south for more than 250 miles to the Salinas River. From this point it turns southeastward to the Conchos which flows for miles along the southern boundary of the Eocene deposits. The contact between the Cretaceous and the Eocene in Mexico was first found on the Arroyo Caballero, a small creek which empties into the Rio Grande on the Mexican side some three or four miles north of the Maverick-Webb County Line in Texas. From this point the contact runs southwest

to the hills north of Azulejo, where it turns and runs a little east of south, crossing the Salado River near Rodriguez, the Sabinas near Piedras Pintas and the Salinas at Ramones. It was not traced between the Salinas and the Conchos rivers, but it was found on the latter stream near Panalito and traced in a general way southeastward to the Zarzizal. Actual contacts were found in a number of places and the relations determined in others by such proximity of the deposits of the two formations as renders the line here given a fair approximation of the existing conditions.

The upper beds of the Escondido formation are well exposed on the Rio Grande between Las Isletas and the Arroyo Caballero. They consist chiefly of greenish blue shales with calcareous bands overlain by brownish ferruginous sandy clays and sands. The calcareous bands of the lower division carry *Volutomorpha texana* Con., *Buccinopsis parryi* Con., and other gasteropods in large numbers. The overlying sands carry *Sphenodiscus pleurisepta* Con., and large *Turritella.* The following section was made a few yards above the mouth of the Arroyo Caballero:

	Feet.
Alluvial material	4 to 6
Tertiary:	
Yellowish clay	6 to 8
Hard bluish gray sandstone with *Ostrea pulaskensis, Turritella,* etc.	6
Cretaceous:	
Bluish sand with *Sphenodiscus pleurisepta*	6
Black hard sandstone	2
Laminated blue clay	6

Other exposures showing similar contacts were seen in the vicinity.[4] No evidence was observed of erosion of the Escondido beds before deposition of the Midway, but the beds of the two formations dip at different angles and to the southward the Midway is found in contact with what are seemingly lower horizons of the Escondido and with the

[4] Note—For details of similar contacts on the Texas side, along the river bluffs and in the uplands, see Stephenson, L. W., "The Cretaceous-Tertiary Contact," U. S. G. S. Prof. Paper 90-J, 1915.

Papagallos shales which are supposed to underlie the Escondido, thus indicating an unconformable overlap.

Amole Creek flows in a long narrow valley in which the Amole Ranch is located. After crossing the creek west of Perros Bravos the country for several miles to the west is covered with the Reynosa, but after passing this, the road crosses a series of small benches made up of thinly bedded yellowish sandstones weathering brown and carrying fragments of oysters. Just west of Amole we found a contact between shaly brown sandstone with abundant *Ostrea cortex* Con. and a somewhat similar sand with *Ostrea pulaskensis* Har. This later sand is overlain in the neighborhood of the Cuevas Ranch by grayish yellow sandy clay and this in turn by the Carrizo sand, which to the south becomes the most prominent member of the Tertiary, overlapping in many places both the Lignitic and Midway to a contact with the Cretaceous. The Cretaceous (Escondido) sandstones noted west of Amole also appear along the western side of the Ceja del Macha and as far south as the Pescado Ranch, underlying a dark brown clay carrying boulders and containing broken and worn fragments of *Ostrea cortex,* which we refer to the Midway. South of the Pescado Ranch we find a large area covered by the deposits of the Reynosa and an old lake bottom, beyond which the first recognizable Cretaceous was encountered in the San Antonio hills. These hills on the eastern side of the Salado River appear to be made up principally of the yellow clays of the Escondido with a plating of gravel.

The Salado River flows in a narrow valley, lying between the San Antonio and San Juan hills, and the sections made here gave us the relations of the various members of the Cretaceous, which are found in contact with the Tertiary. On the west side of the Salado, the San Juan Hills are made up of a series of thin to heavy bedded limestones interstratified with thin beds of yellowish clay. This is the type locality of the San Juan beds. Towards the base the limestones are shaly, dark gray in color, and weather gray to whitish. Toward the summit the limestones are of a bluish shade, weathering white. The uppermost beds are sandy and weather to a reddish or rusty brown color. They

carry numerous impressions of ammonites, oysters, and inocerami, which are of forms referable to the Taylor or Austin horizons of the Texas section. These beds underlie the shales of the eastern side of the river. The greater portion of the Salado Valley is filled with a heavy bed of conglomerate, but from near Santa Rita southeastward to Reparo Creek near Rodriguez, a distance of over 25 miles, there are numerous exposures of heavy beds of greenish-yellow sandy clay, which may be the base of the Escondido, overlying a series of blue clays, blue shales and black shales, with indurated bands. These latter clays are laminated and massive, carry more or less selenite, some calcite and barite, and in places boulders of a yellowish brown hard flinty sandstone. No fossils were found in them, but they are the direct stratigraphic continuation of the beds we have called Papagallos. These rest upon the San Juan beds.

The Escondido with *Ostrea cortex* appears on Camaron Creek about midway between the San Antonio Hills and Ceja Madre and in the western slope of the Ceja Madre we find the brown and blue shaly clay and marls of the Midway with *Venericardia alticostata*, etc.

Reparo Creek joins the Salado River just west of Rodriguez. Half a mile above the junction of the streams, we have a section showing a contact in which the yellowish brown shaly clay of the Wilcox rests on the blue Papagallos shales of the Cretaceous, while further up the creek we find the fine-grained brown and gray sandstones of the Carrizo in contact with the Cretaceous shales at several places. This indicates the transgression of both the Wilcox and the Carrizo over the Midway in this locality. From Rodriguez the outcrop of the blue shale continues down the west side of the Salado River to within a few miles of San Jose and then turns southward, crossing the Sabinas west of Piedras Pintas. At Vallecillo we have the San Juan limestones with Inocerami followed to the east by the Papagallos shale and this by the Midway (?) at Piedras Pintas. From here the line of contact runs south to a point three miles east of Cerralvo where there is a range of hills with eastward facing scarp and northeast dip. They have a height of 200 feet and are made up of the blue and yellow shales of the Papagallos which show

in them, here and there, massive blue nodules or boulders which weather white. To the east of these hills lies a valley two miles wide, and the hills which form its eastern margin are composed of the sands and clays of the Midway.

The Papagallos Mountains lying west of Ramones rise somewhat abruptly from the river and at the distance of a mile attain an elevation of 800 feet. So far as can be seen, the range is made up of highly metamorphosed blue shales, which weather white on exposure and which have been folded into a sharp anticlinal, the dip of which on its eastern slope is as much as 60 degrees, while the dips on the west vary from 30 to 70. The entire valley to the west seems underlain by the same shales but with greatly lessened dips, and these form small hills at Ayancual and elsewhere. These shales also stretch to the east and exposures on the river show that they were considerably disturbed and crumpled prior to the deposition of the Eocene beds. These beds were not traced between the Pesqueria and the Conchos, the line of travel lying east of them and over the Tertiary deposits.

On the Conchos River the conditions appear to be similar to those on the Salinas and the only exposures of the Papagallos shales seen were in the river below the Tertiary beds. The main body of the Cretaceous deposits lies west of Vaqueria. They then swing eastward around Burgos Peak, southeast of which the San Juan limestone is found in a canyon. From this locality several poor specimens of ammonites, including a *Mortoniceras* (?), sp. were collected, of which Dr. T. W. Stanton says: "The genus *Mortoniceras* occurs in the San Carlos beds, in the Austin chalk, and in the Tombigbee sand. If correctly identified, the presence of this genus probably means the limestone is not younger than the Taylor marl and may not be younger than the Austin chalk." To the southeast of this on the road to Cruillas the blue shales come in again. Northwest of Abasolo the San Juan limestones appear, while Abasolo itself is on the blue Papagallos shales and these extend southward along the river as far as Soto la Marina, at which place they are also found in wells. In this region they are overlain in places by the yellow clays of the San Fernando and by the Coquina limestone and the Reynosa.

Between Soto la Marina and San Rafael the only contacts observed were between the San Fernando and the eruptives lying east of the Tamaulipas Range.

THE TERTIARIES

Our examination of the deposits occurring along the Rio Grande and overlying the Escondido failed to show any beds of the Eocene of later age than the Frio substage of the Claiborne. This was followed directly by our Oakville or upper Miocene. No Oligocene or lower Miocene are present there, so far as our present knowledge serves.

The formations recognized are: [5, 6, 7, 8]

Claiborne: { Frio, Fayette, Yegua, Marine, Carrizo }

Wilcox,

Midway.

Between the Rio Grande and the Conchos, however, we find the Oligocene coming in between the Frio and overlying materials and to the south it attains a strong development.

Briefly stated, the characteristics of the several divisions of the Eocene as known on the Rio Grande are as follows:

MIDWAY

Gray clays with limestone concretions overlain by bluish shales and shaly sandstone interstratified with ferruginous sandstone, both series carrying *Venericardia alticostata, V. planicosta, Ostrea pulaskensis, Cucullæa macrodonta* and other forms.

WILCOX

A lower series consisting of blue and gray sandy shales, light gray sandstones and bluish, carbonaceous, sandy shale

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5 Dumble, E. T., "The Cenozoic Deposits of Texas," Jour. Geology.

6 Vaughan, T. W., Reconnaissance of the Rio Grande Coal Fields of Texas, U. S. G. S., Bull. 164, 1900.

7 Dumble, E. T., "Geology of Southwestern Texas," Trans. Am. Inst. Min. Eng., 1902.

8 Dumble, E. T., The Carrizo Sands, Trans. Tex. Acad. Sci., 1911.

with sulphur which is overlain by a second series, comprising black, lignitic, sandy shales with concretions or boulders of gray carbonate of iron, weathering red, lignitic deposits, etc. Fragments of Cardita, etc.

CLAIBORNE

The Claiborne, as a whole, comprises several alternations of deposits of clays and sands, and for purposes of description and mapping, is divided into substages.

Carrizo Sands

Sandstones of varying color, texture and thickness. The prevailing color is a grayish yellow, weathering light brown. Some of the beds are white when freshly broken. In texture they range from fairly hard sandstone, lying in beds of two to four feet or more in thickness, to thin slabby, fairly soft, and almost shaly structure. No fossils except a few plant remains have been found in them.

Marine Beds

Greenish clays and lignitic sands with palmetto and other plant remains, and some lignite, overlain by carbonaceous clays and sands with gypsum and particles of lignite, capped by brown or buff sandstone. These beds are not so glauconitic on the Rio Grande as they are in eastern Texas. This substage usually carries an abundant and characteristic fauna, including such forms as *Venericardia planicosta* Lam., *Anomia ephippioides* Gabb, *Ostrea divaricata, Nassa texana* Gabb, *Distortix septemdentata* Gabb.

Yegua

At the base, interbedded brown sands, chocolate clays with green sand, and lenticular masses of red sandstone; then buff and greenish sands slightly calcareous with occasional bands of limestones, gypsum and cannon-ball concretions abundant. Buff sandstone overlain by blue and green ferruginous clays with calcareous concretions followed by yellow sandy clay form the upper portion of the measures. In places the concretions in these beds carry aragonite and chalcedony. While not fossiliferous throughout, the beds carry a typical Claiborne fauna and are characterized by *Tellina mooreana* Gabb, var., *Turritella houstonia* Har., *Natica recurva* Aldrich.

Fayette

Buff sandstone with greenish, sandy clay, lignitic clays with concretions and some lignite, opalized wood and chalcedony. Fossils are abundant in these beds along the Rio Grande; the most characteristic being *Ostrea alabamiensis contracta, Cornulina armigera heilpriniana* Har., *Cerithium pliciferum* Heilp.

Frio

Gypseous clays with sands. Clays gray and green in color, often weathering white and containing leaf impressions and ferruginous and calcareous concretions. The fossils, which are not numerous, are oysters of smaller size than those of the Fayette, *Corbula,* etc.

AREAL DISTRIBUTION OF THE TERTIARIES

Midway and Wilcox

While there are numerous localities at which it is possible to distinguish the various stages of the Eocene, by their several lithologic and faunal characteristics, it will require more detailed work to show the exact areal distribution of the lower members. This is due to general similarity of materials, scarcity of distinguishing fossils at many places, the successive overlapping of the upper members upon the lower, and the widespread occurrence of the Reynosa, which covers them over many square miles. This applies especially to the Midway and Wilcox, and to the Carrizo Sands of the Claiborne. For this article, therefore, the area occupied by the deposits of these stages will be treated as a unit, noting the various occurrences of each where identified, but leaving the area as a whole undifferentiated. The area has for its western boundary, along which we may find any or all of these deposits, the Cretaceous-Tertiary contact just described. Its eastern border, which is the line of contact of the Marine substage with the Carrizo Sands, crosses the Rio Grande just south of the mouth of Espado Creek and, running southeastward by Hidalgo, crosses the International Railroad near Jarita, 16 miles west of Laredo, and the Salado at Los Moros, 10 miles west of Guerrero. It then takes a southerly

course to its crossing of the railroad and Pesqueria River, a short distance west of Herreras, and then southeastward again to near Vaqueria on the Conchos, which is near its southernmost exposure.

Along the Rio Grande the Midway with its fossiliferous beds is fairly persistent for some distance and forms the base of the hills to a point a mile or more south of the mouth of Penitas Creek. But it is not often the surface rock, as it is usually covered by the Wilcox or Carrizo.

The Wilcox appears only in limited areas, having probably been subjected to erosion before the deposition of the Carrizo and while it occasionally appears on this river between the Midway and Carrizo, there are many exposures in which it is lacking and the Carrizo rests directly upon the Midway. This is well shown in the Cerrita Prieta and the hills to the south.

South of the river the brown, fossiliferous sandstone of the Midway is well exposed for several miles and it is seen again at a crossing of Amole Creek nine miles southwest of Perros Bravos.

On Amole Creek the Wilcox appears below the Carrizo in places, while at others the Carrizo Sands rest directly upon the Midway or even on the Escondido beds.

West of Amole Creek the Midway sandstone is underlain by shaly sandstones with small oysters, and these are underlain by the Escondido beds with *Ostrea cortex*. Along the western side of the Ceja del Pescado, a low range of hills, lying south of Azulejo, there appears a series of shales and sandstones weathering to a dark brown, clayey soil carrying the distinctive boulders of the Midway, and broken fragments of *Ostrea cortex* as found at base of the Midway elsewhere. This range of hills stretches southward for some miles.

The Carrizo, as has been stated, has a very wide extension in the northern part of the area and forms the top and eastern slope of the various small groups and ranges of hills north of the Arroyo Agua Verde and of the longer range known as the Ceja del Macha and Ceja Madre, which extends from Azulejo nearly to the Salado River.

South of the Salado, the conditions seem to be different

from those in the territory nearer the Rio Grande. The Carrizo is less dominant, in fact between the Salado and the Pesqueria and along the railroad we observed no beds certainly referable to the Carrizo, although it doubtless occurs. While the exposures of the Wilcox are still limited, the Midway shows much greater development.

On the road from Mier to Cerralvo, we find 2½ miles west of La Masa, a range of hills trending northwest and southeast and having a northeast dip. The section shows:

	Feet.
Sandstone	8
Yellowish clay	10
Fine-grained, smooth, yellow sandstone	10
Blue clays weathering yellow	20
Alternating clays and sandstones in thin beds.	

The character of these beds and their stratigraphic position warrant their reference to the Midway. They occur again at a creek crossing 10 miles south of Cerralvo on the Herreras road and a hill in this vicinity is capped with fossiliferous sandstone showing Midway forms. They also have a wide development in the valley of the Pesqueria River between Ramones and Herreras.

A hill north of La Masa gives us a section of the Wilcox clays overlain by the Carrizo, and similar beds were observed southeast of Cerralvo.

The town of Ramones is located on the blue shale of the Papagallos and exposures are seen in the river bed for two or three miles east of the town, underlying the yellow clays of the Midway and the calcareous conglomerate of the Reynosa.

A quarry 2½ miles north of Ramones gives the following section:

	Feet.
Thin soil	1
Thin bed of ferruginous sandstone containing *Venericardia alticostata, Ostrea pulaskensis,* etc.	1 to 1½
Thinly laminated shale, gray and black	4 to 12
Soft gray sandstone	10

Another quarry to the south of this, on the ridge dividing the river and Ayancual Creek, shows the same limestone with the same fossils and they are seen again at the head of an old irrigation ditch near Hacienda Nueva, five miles west of Herreras. North of the river the Midway includes a series of interstratified blue and brown, shaly clay and gray, brown or white sandstones which extend for several miles and find in the Alto Colorado their most conspicuous development. This hill is three miles north of kilometer 1121 on the railroad. It shows the following section:

	Feet.
Brownish gray, heavy bedded sandstone	3
Limestone, fossiliferous	1
Brownish sandstone	8
Blue clay, weathering yellow	3
Yellow brown sandstone, somewhat calcareous, fossiliferous	160
Yellow, shaly clay	80

The fossils are not very well preserved, but include *Ostrea pulaskensis, O. crenulimarginata, Venericardia planicosta, V. alticostata, Turritella,* and other undetermined gasteropods. The same beds were also observed 16 miles southeast of Ramones on the road to China, which was the most southerly exposure of them which we could identify.

A mile southeast of Comitas, on the road from Ramones to China, there is an exposure of typical Wilcox strata but without any fossils. It consists of heavy beds of clay with nodules of clay ironstone, weathering red.

Claiborne

Carrizo

South of the Pesqueria, sandstones, probably referable to Carrizo, were seen 2½ miles west of San Juan and there was also seen a gray sandstone with westerly dip a few miles north of Vaqueria, which may represent it. The greatest development of these sands, however, both in Texas and Mexico, is found in the drainage area of the Rio Grande.

Marine

The beds belonging to the Marine substage of the Claiborne, as seen on the Rio Grande, have a wide development, the river flowing through them from the mouth of Espado Creek to a point eight miles south of Laredo, a total distance of 50 miles, but this is at an angle to the dip of the beds. They narrow rapidly to the south and where they cross the Salado River west of Guerrero, their outcrop is not more than five or six miles wide. East of Cerralvo, they occupy the area between La Masa and the General Trevino Ranch.

Like the Midway, the Marine beds are well developed in the valley of the Salinas. Indeed, the valley of the San Juan, of which the Salinas is a part, gives by far the most complete and satisfactory section of the Atlantic coast type of Eocene deposits which we have so far found in Mexico. Two miles north of Herreras, there is a hill 170 feet in height, known as Loma Larga, with an escarpment facing west and south, the beds of which have a southeast dip. The section is:

	Feet.
Reynosa limestone	4
White clay with small concretions	6
Yellow clay with interbedded micaceous sandstone	30
Greenish sandy clay	10
Blue shale and clay with septaria	120

The fossils identified from this locality include *Venericardia planicosta V. potopacoensis*[6] and others. An exposure on the railroad half a mile east of Herreras shows similar beds with numerous fossils belonging to the Marine stage. This section was repeated in an exposure on the river south of the railroad. A mile east of Herreras, a long shallow cutting on the railroad shows a section of grayish yellow clay and thin calcareous sandstone. Here were found quantities of well preserved fossils, consisting principally of *Venericardia planicosta* and *V. potopacoensis.* The position and dip of these beds would place them at the base of, or below, the

6 This form is well known in the Maryland Tertiaries but has not been found previously in the Gulf Tertiaries.

beds exposed in the Loma Larga. East of this cutting we found gray sandstones and shales and brown, ferruginous sandstones which extend east within a mile of La Laja. Among the fossils found in them were *Ostrea alabamiensis, O. sellæformis, Venericardia planicosta, Pyrula*, sp. (?), *Cassidaria*, sp. (?) and many smaller forms. Continuing south of the Pesqueria, there is found three miles southeast of Comitas a succession of low ridges caused by the upturned edges of sandstones of this age with an abundant fauna, which, however, is very firmly embedded in the calcareous sands. On the San Juan River west of China and between Barranca and San Juan, the Marine beds of clays and sands with *Ostrea alabamiensis* are found. The road from San Juan to Vaqueria shows many exposures of these beds. A hill half a mile west of La Ciga gives, at its base, a good section of the clays and sands with *Venericardia potopacoensis* and other forms. At Jaboncillos Ranch, 20 miles south of San Juan, a calcareous band was found, composed largely of *Venericardia potopacoensis* and this stratum was followed for 10 miles in a southeasterly direction toward the Conchos. It dips N. E. 10°. While no fossils were found which positively identified them as Marine, it is probable that the yellow clays and sands along the river east of Vaqueria belong to this substage.

Yegua

The beds belonging to the Yegua substage form the surface rocks on the Rio Grande from eight miles south of Laredo nearly to the mouth of the Salado River. Their eastern border in this area is found west of Guerrero on the Salado and extending southward, crossing the road from Mier to Monterey, a short distance east of the Borregas Ranch; the Brownsville-Monterey railroad, 6 miles east of La Laja; the San Juan River just west of China, and the Conchos west of Mendez. Its fossils are principally oysters and are usually poorly preserved. They are probably *Ostrea alabamiensis.* At the foot of a hill a short distance east of Borregas Ranch, there is an exposure of beds of purple sandstones and clays, one of which is composed almost entirely of the cannon-ball concretions of the Yegua. From these beds we collected the

following fossils: *Venericardia planicosta, Volutilithes petrosa, Pseudoluva vetusta, Natica recurva, Harpa*, sp., *Pecten*, sp., etc. At the top of the hill are the Fayette sands with *Ostrea contracta.* Southwest of Borregas the road passes hills of reddish and purplish sandstone and yellowish sandy clays which are also red in places. These beds have a northeast dip and are visible until the San Domingo Ranch is reached, 6 miles west of Borregas. Beyond this the country is level with no exposures for several miles until we find a hill which shows the purple sands of the Yegua underlain by the gray and yellow sandy clays of the Marine. Near La Laja, which is on the railway near the Salinas River, the Yegua occurs as heavy bedded gray, bluish gray, and red sandstone with blue, brownish yellow and red clay shales, followed by thinly stratified gray clays and sandstones. The only fossils found were fragments of oysters. Half a mile west of La Ciga, a small hill showing Marine strata at its base seems to be capped with Yegua, a few fossils, including *Natica recurva*, indicating that age. East of La Ciga the chocolate sandstones and clays with cannon-ball concretions are exposed in a low ridge for several miles. The Yegua continues to the Loma ford on the San Juan River, two or three miles west of China. On the Conchos River, one mile east of Angeles, where a large creek enters the river from the south, there is a bluff some 75 feet in height with 25 feet of purple lignitic shale at base, capped by yellow clays with shaly sandstones and beds with nodules of carbonate iron weathering red. This is typical Yegua. The latest beds of Yegua seen were east of Sonada, where there are exposures of blue and yellowish clays with gypsum, interbedded with beds of sandstone four inches to two feet in thickness. Beds of brown clays in a hill one mile west of Mendez mark the top of its development here. No fossils were found here, but its lithologic character and stratigraphic position warrant the reference.

Fayette

The Fayette, like the Carrizo, is predominantly sandy. Like the Carrizo also, the Fayette, at times, overlaps the lower substages of the Eocene. Its exposure on the Rio Grande is fully equal to that of the Marine, stretching from

just north of the junction of the Salado and Rio Grande almost to the mouth of the San Juan. On the Rio Grande it carries many fossils connecting it directly with the Claiborne, together with others distinctively its own, the most prominent of which is the large oyster, *Ostrea alabamiensis contracta* Conrad, by which we have identified it as far south as the Conchos.

The town of Mier is on the Fayette sands, which here have a northeast dip. They are well shown in places along the road from Mier to Camargo and on the river. The upper beds are a series of yellow sands and greenish yellow clays with gypsum, overlying yellow sandy clay with *Ostrea contracta*, and sandstone beds alternating with yellow clays. Going southwest from Mier we pass over the same beds, until near Borregas at the edge of a scarp facing northwest, we find the lowest Fayette with *Ostrea contracta*. This is underlain at the bottom of the hill by Yegua. About a mile north of Borregas Ranch an outlying hill shows the Fayette as yellowish sand and pinkish sands and clays with leaf impressions. The section is:

	Feet.
Yellow sandstone, *Ostrea contracta*	3
Yellowish and purple clay	20
Clayey limestone, fossiliferous	1
Yellow and pinkish clays	10
Yellow sandstone, leaf impressions	3

These beds dip N. E. On the Matamoras-Monterey railroad the Fayette sands begin six miles east of La Laja. The exposures show light gray, almost white, sandstone ranging from two to four feet in thickness, quartzitic in places, and interbedded with softer sands and clays. West of Los Aldamas is a bluff of sandstone with oysters. The top weathers very rough. The Fayette beds have a northeast dip and extend along the railroad some five miles or more east of the river. In the bank of the San Juan River north of China, these sandstones and clays make their appearance and the road from China to Chilarios shows them as a series of gray sandstones and clays, some of the sandstones being concretionary and some thin-bedded and ripple marked. Near

Chilarios the oyster beds are found with fragments of *Ostrea contracta*. The development of the Fayette sands in the vicinity of the Conchos River is quite extensive. They form the western flank of the Sierra de Pomaranes and the continuation of these hills to the south and west of the river, overlapping the lower beds of the Tertiary to a contact with the Cretaceous (San Juan) limestones east of Burgos Peak. It is only the erosion of the river which has brought to light the few exposures of the lower beds of the Eocene, which we have described as in its basin. The upper beds of the Fayette which cross the river at and east of San Diego and the San Pedro Ranch, are composed of massive rough weathering sandstone with a few large oysters. These extend up the river valley to within a mile of Mendez, where they rest on the Yegua. They appear west of this in a hill near Piedras. As nearly as we can determine, they form the plateau north of the river. The same beds are seen forming the plateau southward toward Burgos; on a creek west of Burgos, dipping west at high angle and overlain by Equus beds; and are found again three miles east of Burgos. They also form the body of Mt. Corcovada, where they show a westerly dip. The road from Burgos to Cruillas has few exposures and these only of yellow clays, but between Cruillas and Choreras the gray sandstone of the Fayette occurs in a hill, and it is found lying in low ridges a few miles southwest of Choreras. This is the last exposure we are able to identify as Eocene in this area.

To the west the Cretaceous limestones and shales come in and continue down the Soto la Marina to Abasolo, while from Choreras southward, the San Fernando practically covers all the lower beds and rests directly upon the Cretaceous.

Frio

On the Rio Grande the Frio beds are found capping the Fayette just south of Roma and disappearing under the Oakville below Rio Grande City. They form the surface rocks, where the Reynosa is absent, in the valley and to the north of the San Juan River for 30 miles or more southwest of Camargo.

South of the Salinas River on the road from China to Laguna de los Indios we find, beginning a mile west of Chilarios, a series of yellow clays with nodules of red clay, ironstone and gypsum, which apparently belong to the Frio. Southeast of Chilarios all the washes and gullies show the yellow gypseous clays with only a few shaly sandstone beds. These carry the small oyster of the Frio. Just how far these beds extend to the southeast before they are covered by the yellow sandy clays of the Oligocene, could not be determined owing to lack of suitable exposures. Similar clays were, however, observed 24 miles southeast of Chilarios. The best development of these beds was found in the region of the Conchos River. Between Tepetate and the San Francisco Ranch, northwest of San Fernando, they comprise yellow clays and soft gray sandstones, dipping northeast and carrying oysters. The hills stretching northwest from this locality are largely made up of these clays and sands with beds of gypsum and in the Sierra de Pomeranes they also show a considerable thickness and are interbedded with or carry gypsum in all its varieties. Here they are underlain by the Fayette and capped by the San Fernando. At San Diego, which is at the southern point of these hills, the Frio shows in a ridge capped with three feet of massive gypsum underlain by greenish clays weathering white and carrying the Frio oysters. Their extension south of the Conchos, if any, has not yet been worked out.

So far as our investigations show, all exposures of Lower Eocene (Midway and Wilcox) deposits are confined to the limits of the present drainage basin of the Rio Grande. Whether this coincides with the limits of the Rio Grande embayment of Lower Eocene time cannot be stated. The deposits of the Middle Eocene, however, extend south through the basin of the Conchos River.

From the evidence before us it appears that following the close of the Wilcox deposition there was a period of elevation and erosion, succeeded at the beginning of the Lower Claiborne by a rather rapid incursion of the sea which transgressed the earlier Tertiary area in places and allowed the deposition of the Carrizo sands. During the succeeding substages of the Lower Claiborne there was a gradual sinking

of the eastern face of the Tamaulipas Range, permitting the later deposits to overlap the earlier, and its close was marked by gradual dessication and the formation of the numerous beds of gypsum found in the Frio clays. Here, as in Texas, no beds have been recognized which are in any way referable to the Upper Claiborne.

UPPER EOCENE

Between the exposures of the Frio on the Rio Grande and southward and the first deposits clearly referable to the Oligocene there is quite a belt of country, largely covered by the Reynosa. It is entirely possible that within its limits there may exist representatives of the Upper Eocene or Jackson such as occur in eastern Texas, but which are apparently entirely wanting in the valley of the Rio Grande. The only deposits actually observed that seem in any way related to this period were found overlying the Frio on the road from China to Laguna de los Indios. The Frio clays and soft shaly sandstones formed the country rock from Chilarios southeastward for some distance. No change in character of deposits were seen for 24 miles, but at a so-called Mina Antigua some three miles southeast of Rancheria, the old shaft, 20 feet deep with tunnel to east of 40 feet, showed principally sands. The tunnel was in a bed of coarse-grained bluish sand carrying pyrite, gypsum, and sulphur and entirely different from any Frio materials. From this point to Laguna de los Indios, some 18 miles, the surface is sandy. The well at the ranch is 80 feet in depth, the materials through which it was sunk being coarse-grained bluish sand with gypsum similar to that found at the old mine. The sand was here interbedded with yellow clay which carried a number of poorly preserved fossils. Dr. W. H. Dall, who looked them over, stated that they contained a *Pecten* recalling *P. poulsoni, Tellina* and *Cardium* or *Venericardia,* which, while not characteristic, seemed to indicate an Upper Eocene or Oligocene horizon. This may prove to be the southern extension of the Jackson of east Texas. Similar sands covered by the Reynosa occur also in ridges northwest of the ranch.

OLIGOCENE

Overlying the beds we have here referred to the Eocene, we find a series of yellow sands, clays and calcareous beds which carry an Oligocene fauna. We have called these the San Fernando from the fine exposures of the beds in the vicinity of the town of that name on the Conchos River. As will appear, these beds all belong to the Upper Oligocene and up to this time no beds of the Lower Oligocene, like those of the Buenavista River region with *Orbitoides papyracea,* etc., have been recognized in the area north of the Tamaulipas Range. From our present knowledge it would seem that while the Lower Eocene deposits show a gradual overlapping southward until the Conchos is reached, the Oligocene, on the contrary, shows an overlapping northward to the same region, so that along the Conchos the uppermost beds of the Oligocene are in contact with the members of the Eocene there exposed.

In the region of San Jose de las Rusias,[7] which occupies the extreme southern portion of this area, we have numerous exposures of the Upper Oligocene. It apparently immediately overlies the Cretaceous and is penetrated by eruptive rocks which are connected with or extend eastward from the Tamaulipas Range. In places these eruptives are of a porphyritic texture but at others they are basalts. They occur as masses, ridges or isolated peaks throughout the region and the Oligocene beds in immediate contact with them are more or less metamorphosed and show at times considerable dips. These eruptive rocks, in places, extend to within two or three miles of the Gulf coast.

The lower beds of the Oligocene in this region are yellow clays, which are altered in places and appear as hardened shales, and clayey limestones carrying *Cristellaria, Nummulites,* corals and molluscan forms followed by yellow sands and clays with an extensive fauna. The beds have a general southeast dip. At San Rafael on the Zarzizal River at the extreme southern end of the district, the contact of the eruptives with the yellow clays is well shown.

Northward of San Rafael toward the ranch of San Jose de las Rusias, the principal exposures are of eruptive rocks,

[7] An excellent description of this region will be found in "Boletin del Instituto Geologico de Mexico," No. 26, Juan D. Villarello.

porphyries and basalts, with occasional outcrops of the hardened shale and the yellow clays of the Oligocene.

Lying four to six miles east of San Rafael there is a range of hills 300 to 400 feet in height, composed of alternating beds of yellow clays and clayey limestones carrying poorly preserved molluscan forms together with great numbers of *Cristellaria,* corals, and some *Nummulites.* Among the corals collected here, Dr. T. W. Vaughan determined *Favosites* (?) *polygonalis* Duncan, *Goniastrea antiguensis* Duncan, *Acropora* (?) sp., *Orbicella,* n. sp., and *Goniopora,* sp., very similar to or identical with an Antiguan species. These, he says, indicate an Upper Oligocene horizon about equivalent to the Chatahoochee of Georgia.

To the east of this range stretches an open prairie country in which there is a ridge of eruptive material (basalt) which runs parallel with the range of hills and has a width of five miles. To the east of this eruptive ridge and only two miles from the Gulf shore a sandstone was found very similar in character to those of the Pecten bed on the Conchos and carrying the same Pectens.

Around the San Jose de las Rusias Ranch the beds which are exposed show considerable disturbance. Immediately at the ranch the beds, which are fossiliferous sandstones, dip northwest at a high angle. Northeast of the ranch a hill 60 feet high shows beds of yellow clay overlain by hard calcareous sandstone which weathers into rounded masses. A great number of corals occur within the clays and in the sandstone. Dr. Vaughan reports *Orbicella cellulosa* Duncan, and *Meandrina,* n. sp. from this locality. A short distance north of this hill is another in which the basalt has come up through the Oligocene beds which are here impregnated with asphalt. To the east of the ranch, some few miles, there is a range of hills 400 feet high capped with the Coquina, and lying to the east of the range another volcanic hill. North of the Soto la Marina the same clays and limestones occur and east of the Salitre Ranch, the same *Orbicella* was found as that occurring southeast of San Rafael, together with specimens of a new genus of the fungid corals. At and around Salitre were found three species of echinoderms, the

only ones so far found in beds we have recognized as Oligocene. The following is a section of the deposits near Salitre:

	Feet.
Coarse gray sandstone	20
Yellow clay, fossiliferous	100
Hard yellow clayey limestone, fossiliferous	4
Yellow sandy clay	10
Yellow sandstone, fossiliferous	8
Yellow clays and sands	10

A range of hills known as the Martines which are similar to those seen east of San Jose de las Rusias and of about equal height is found here extending from Salitre southward nearly to the Soto la Marina River. Along the Conchos River the exposures of the Oligocene are of beds higher in the series than the bulk of those of San Jose de las Rusias, being represented in that region by the Pecten beds which lie along its extreme eastern border. In the valley of the Conchos the greenish clays and soft sands with their beds of gypsum, which are part of the Frio, are found as far east as Tepetate and forming the body of the hills lying directly north. Beds of the Oligocene are found not only overlying these beds at this point, but stretching several miles westward, showing a clear overlap to lower beds of the Eocene section.

What seem to be the lowest beds of the San Fernando section were found three miles west of that town, and consist of cross-bedded gray sandstones with a thickness of 60 feet. Half a mile east the beds form a series of falls in the river and we have the following section:

	Feet.
Conglomerate	4
Cross-bedded sandstone indurated and with bands of fossils	70
Yellowish sandstones with fossils	3
Gray sandstones, weathering in holes, few fossils	4

The cross-bedded sandstone carries a great number of a large Pecten, which are well preserved and, as it appears to be a well marked horizon, we have called it the Pecten bed. It is immediately overlain by beds of sandy clay with fragments

of shells, a well preserved large gasteropod, and numerous claws of a crustacean. These beds continue down the river. A bluff opposite San Fernando shows:

	Feet.
Reynosa	20
Yellow clay	20
Yellow sandy clay with many fossils	4
Cross-bedded sandstone	30

The river here runs south almost with the strike of the beds; thus the same or similar beds are seen for three or four miles down-stream, when the river again swings east. Here the clayey sands seen at the falls above the Pecten bed carry not only the large gasteropod and crustacean claws, but grahamite and fragments of lignite also. Hills a mile east of this locality are composed of soft yellowish sandstone and clay beds with a Coquina limestone on top. Still south of this a section one-half mile east of Algodones shows heavy beds of yellow sandy clay overlain by yellow clay containing casts of fossils and many valves of Pecten. This was followed by another bed of yellow clay and this by a series of calcareous sands and silicious gravel 20 feet thick with numerous casts of a Cardita-like shell and single valves of large oysters which appear to have been transported. The same beds are also found in the hill one mile north of Algodones and extending two miles or more to the eastward. These Oligocene sands and clays also form the body of the hills north of San Rafael, on the Conchos, and the eastern flank of the Pomeranes. To the north and east of this locality their extension is largely hidden by the Reynosa covering.

Neocene

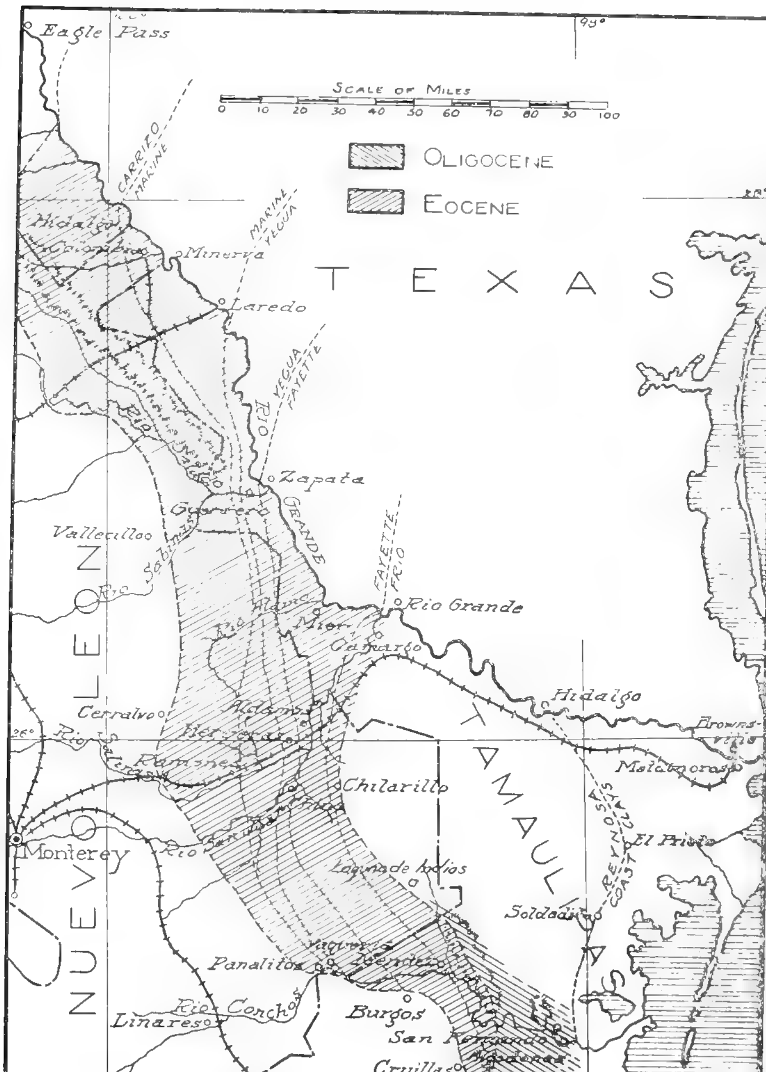
Coquina Limestone

Overlying these fossiliferous sands and sandy clays of the upper San Fernando, which seem to have a thickness of 300 feet or over, we find a bed of Coquina limestone, or possibly a succession of such beds. Half a mile east of the bluff near San Fernando, the Coquina limestone was found overlying the beds of the section as already given, and similar Coquina is found near San Diego, capping a small hill and occupying

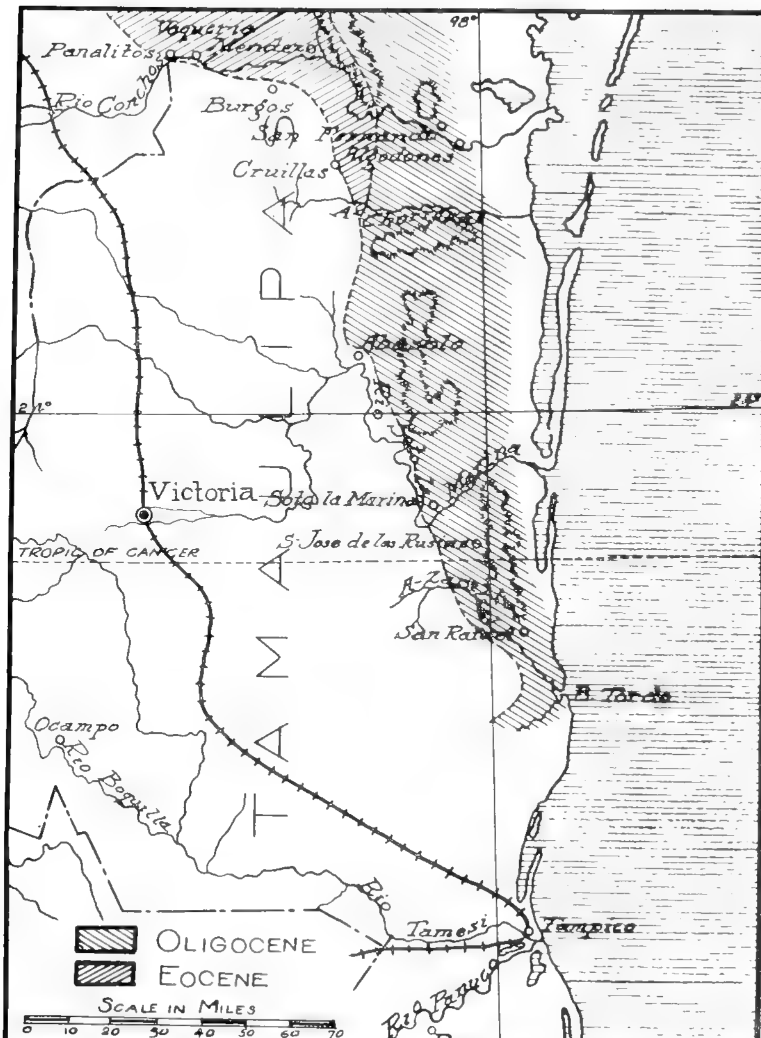
the valley of the river for two miles to the southeast. This is more than 20 miles west of the exposure of any beds we have so far recognized as Oligocene. The Coquina was also seen west of Chorreras, where it apparently rests upon the Fayette and between Abasolo and Soto la Marina in contact with the Cretaceous. In the San Jose de las Rusias region it was also observed in several places forming the tops of the hills. It is probably of Neocene age.

Reynosa

The eastern border of the outcrop of the Reynosa limestone was traced by Professor Cummins from Reynosa southward to the Conchos River in the vicinity of Rinconada. From this border the Reynosa spreads westward covering more or less of the area underlain by the Tertiaries here described, and in places extends to the foot of the Sierra Madre. One of the best exposures seen was at Abasolo in the Soto la Marina River, where the Reynosa (overlying 60 feet of blue Papagallos shale) shows 40 feet of a conglomerate of blue limestone pebbles overlain by 60 feet of tuffaceous limestone. Many good sections of it were secured from the logs of water wells in the area. At several places small basins were found in it, in which deposits of Equus bed material and fossils occur as they do around San Diego, in Duval County, Texas.



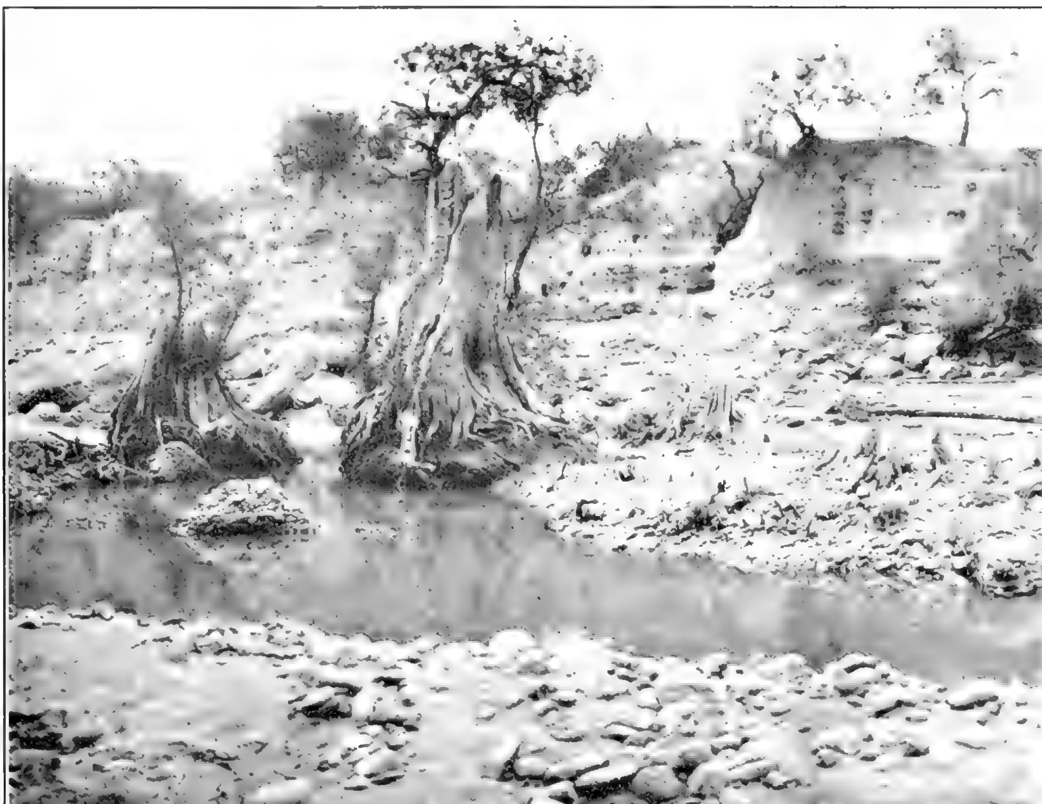
AREAL DISTRIBUTION OF THE EOCENE DEPOSITS OF NORTHEASTERN MEXICO.



AREAL DISTRIBUTION OF THE OLIGOCENE DEPOSITS OF NORTHEASTERN MEXICO

Fig. 1 ESCONDIDO SANDS AT KINGFISHER CROSSING, RIO GRANDE

Fig. 2—PAPAGALLOS SHALES OVERLAIN BY REYNOSA ON SALINAS RIVER.



FAYETTE OVERLAIN BY REYNOSA ON CONCHOS RIVER.

PROCEEDINGS

OF THE

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VII

REPORT OF THE PRESIDENT OF THE ACADEMY FOR THE YEAR 1915

BY

C. E. GRUNSKY

President of the Academy

For the year which has just closed the Academy can again record progress. The construction of the Museum building in Golden Gate Park had been sufficiently advanced in August, 1915, to make possible a transfer of the Academy's collections, of its library, and of its offices, from the temporary quarters of the last few years at No. 343 Sansome Street.

This annual meeting is notable, therefore, because it is the first annual meeting, and in fact, the first meeting, at the Academy's new quarters in its Museum building in Golden Gate Park. It may be well in passing again to call attention to the fact that the privilege to build here was granted by the people of San Francisco at a public election on November 15, 1910.

The Academy has planned a building which is specially adapted to Museum purposes but which will also afford adequate space and facilities for research work and for the storage and preservation of research material.

Of the proposed building a first section only has been erected, covering about one-third of the ground space which it is proposed ultimately to occupy. The cost of the building

to February 1, 1916, has been in round numbers $175,600 of which all except about $125 has been paid.

The building has not yet been opened to the public, but it is expected that the installation of the habitat groups of mammals and of birds will have been sufficiently advanced to justify a formal opening sometime in May of this year.

The acceptance by the Academy of the offer of Mr. Wm. M. Fitzhugh to exhibit in the Museum building the Fitzhugh-Lowe collection of Indian baskets, Indian stone implements and related articles, has resulted in a well filled hall whose contents are most attractive and instructive. I desire to record at this time not only the Academy's appreciation of having this valuable collection added to its museum, but also the fact that the entire installation including the exhibition cases was made at the expense and under the personal supervision of Mr. Fitzhugh. The Indian baskets in this collection are said to constitute the largest and most complete exhibit of the kind in existence.

Owing to lack of suitable cases and space the Hemphill shell collection remains largely boxed, but it is hoped that something may be done soon toward making it available for study and a portion of it for exhibiton.

The Academy found opportunity to be represented, in a small way, at the Panama-Pacific International Exposition, where, in the Food Products Building, space was secured for a joint exhibit by the Academy and the California Fish and Game Commission. While the allotted space, the best that was available, was altogether too restricted for results that might otherwise have been secured, the exhibit, prepared with material from the Academy's stock by and under the direction and supervision of Mr. John Rowley of the Academy, was nevertheless an effective, attractive display which forecasts what we are now beginning to realize in the habitat groups that are being installed in this building.

The Academy has received a number of valuable donations from the Panama-Pacific International Exposition Company and from various countries which were represented at the Exposition. Full reference to these will be made in the report of the Director of the Museum, and I wish only to say that the Academy is sincerely appreciative

of the good-will which these donations manifest and that it will make the best possible use thereof. Australia, Argentina, New Zealand, China, Japan, Honduras, Guatemala, and the Netherlands are among the contributors. These donations consist largely of minerals and woods, and many other objects, including some desirable pieces of furniture. Similar donations were received from various states, including California, Montana, Missouri, Idaho, Oregon, and Washington. The government of Porto Rico gave a good relief map of Porto Rico and nine excellent large photographs of Porto Rican natural scenery.

A fine specimen of the Florida Manatee was donated by the late Mr. Warren Frazee ("Alligator Joe"), at the suggestion of Mrs. Nellie Waterhouse Dorne, one of our members. The skin and skeleton have been saved.

A large number of valuable specimens and desirable cases and tables were received from the U. S. Bureau of Fisheries.

A large series of minerals, woods, etc., has been contributed by the various Sacramento and San Joaquin Valley County Associations.

The many other donations made during the year to the Academy's museum and library are too numerous for enumeration in this report. They will be referred to in more detail in the report of the Director of the Museum.

The publications of the Academy cover Parts I to VI of Vol. V of the Fourth Series of Proceedings, in all 193 pages.

The activities in the various departments during the year are fully set forth in the reports of the Director of the Museum and of the several curators, and do not require repetition. It need only be stated that the large and continuing demand upon the Academy's financial resources for the installation of the exhibits, has made it necessary to keep the allotments for work in these departments at the lowest possible amounts. The Academy is not in command of resources, in other words, that would enable it to do all that an institution of its character should do for California, for the Pacific Coast, and for the entire Pacific Ocean region.

The curator of botany has been active during the year in enlarging and caring for the herbarium to which many important additions have been made.

The department of paleontology has been very active. Many additions to the collections have been made and several scientific papers based on the department's collections have been published or prepared.

The curator and assistant curator of herpetology have the immense collections of that department installed on shelving and have done much toward increasing the collections.

A few accessions have been received by the departments of mammalogy and ornithology and a beginning has been made with the department of invertebrate zoology.

The curators and their assistants have been alert and efficient in caring for the collections in their charge and their earnestness and enthusiasm deserve and should receive the encouragement of the community and of the entire Pacific Coast.

We may hope that the high class work that is being done, of which some samples of educational value will soon be on display, will attract the attention of the public, and will make clear that ours is an institution for service worthy of generous support by those whose means will permit.

Our building will quickly be filled to capacity. We already know that we will be short of space to display all that has been collected and prepared for attractive educational exhibits.

The Academy's thanks are due, and I take pleasure in expressing them, to those who are devoting of their lives to the scientific and educational work under the Academy's guidance and for which the Academy can provide only inadequate compensation.

The interest displayed in their work, combined with the high order of skill, ability and talent possessed by those who are installing the habitat groups in our Mammal and Bird halls, may be accepted as an assurance that these exhibits will have artistic merit ranking with the best that has yet been produced.

The courtesy of the Mechanics Institute has made it possible to hold the Academy's stated monthly meetings since August at the Mechanics Institute. Up to the present time the Council has not deemed it wise to arrange for these meetings in the Museum building, whose auditorium is not yet ready

for them, and which lacks the convenience of location which can be claimed for the Mechanics Institute.

On behalf of the officers of the Academy I wish to express their appreciation of the help received from members and friends in advancing the Academy's work, and as President I wish to thank all who have in any way contributed to extend the Academy's usefulness.

The present total membership in the Academy is 472, made up of:

Honorary Members	27
Life Members	86
Resident Members	359

During the year 1915 there was an accession of 63 new members, and the Academy lost by death 6, by resignation 25, and by being dropped for arrearages in dues, 9. The net gain in membership during the year has been 23.

The losses by death were:

Greene, Prof. Edward L.	Life Member	November 10,	1915
Günther, Dr. Albert	Honorary	,	1914
Hilgard, Prof. Eugene W.	Honorary	January 8,	1916
Holladay, Mr. S. W.	Life	February 16,	1915
Putnam, Prof. Frederic W.	Honorary	August 14,	1915
Wilson, Mr. J. C.	Resident	,	1915

LECTURES

During the year 1915, 14 free lectures have been delivered at the stated meetings of the Academy, as follows:

January 18. "The Significance of Glaciation in Geologic Time."
Dr. Marsden Manson.

January 29. "The Work of the United States Biological Survey."
W. L. McAtee, U. S. Biological Survey.

February 17. "Explorations of a Sacred Cave in Arizona."
Dr. Walter Hough, Curator of Ethnology, United States National Museum.

March 17. "Liquid Air."
Prof. E. C. Franklin, Professor of Chemistry, Stanford University.

March 26. "International Peace."
Chancellor David Starr Jordan.

APRIL 21.	"Physiographically Unfinished Entrance to San Francisco Bay." Dr. Ruliff S. Holway, Professor of Geography, University of California.
MAY 19.	"The Status and Life History of the Tree Mouse, Phenacomys longicaudus True." Dr. Walter P. Taylor, University of California.
JUNE 16.	"The Food of the Roadrunner in California." Dr. Harold C. Bryant, University of California.
JULY 21.	"The Lessons of the Southeast Wind." Dr. Marsden Manson, San Francisco.
AUGUST 18.	"Administration of Fish and Game Laws." Ernest Schaeffle, Secretary California Fish and Game Commission.
SEPTEMBER 15.	"Snap-shots in Brazil." Prof. E. C. Starks, Stanford University.
OCTOBER 20.	"Pearls and Pearl Culture." Prof. Charles A. Kofoid, University of California.
NOVEMBER 17.	"Some Fishes and Fishing in California and Nevada." Prof. John O. Snyder, Stanford University.
DECEMBER 15.	"Ancient Climates of the West Coast." Dr. James Perrin Smith, Stanford University.

FINANCIAL

The financial transactions of the Academy are fully set forth in the Treasurer's report and in the financial records. From these it appears that our gross annual income is about \$67,500, of which about \$46,272 is the net return from the Academy's Market Street property and about \$1500 is the amount received from members as admission fees and dues. The Academy has recently borrowed the sum of \$32,175 in order to advance the completion of its building and the installation of exhibits. The total obligations on which interest is now being paid is in round numbers \$332,000.

The gross annual receipts from the Market Street property for twelve months are about \$64,272, and the interest on the \$300,000 for which this property is mortgaged to the New York Mutual Life Insurance Company is \$18,000, leaving the net annual return from this property \$46,272, as above stated.

The expenditures in the calendar year 1915 will give some idea of how the available funds, apart from the investment in the Museum building and in exhibits, have been used. The amount of interest paid was \$18,257.05, and interest received

was $1,633.28. The salaries paid during the year amounted to $15,705.35; the insurance paid was $2,120.03, and the general operating expenses were $3,339.94.

These figures show that about $28,000 of the Academy's receipts were available in 1915 for construction and installation of exhibits and that a fair annual surplus may be expected which, after a year or two, will in part be available for reducing the Academy's financial obligations.

The fact that it has been necessary to thus anticipate for a period the usual surplus should cause no regret. We know that the time will come when the results achieved will fully justify the course which has been pursued.

VIII

REPORT OF THE DIRECTOR OF THE MUSEUM FOR THE YEAR 1915

BY

Barton Warren Evermann

Director of the Museum

At the time of the last annual report of the Director of the Museum (January 4, 1915), construction work on the new Museum building had been stopped. The hope was expressed that the difficulties with the contractors would soon be adjusted and that the work might be resumed at an early date. This hope was realized. A satisfactory adjustment was made and building operations were resumed early in March. The work proceeded with reasonable celerity and the research wing was ready for occupancy the last week in August. During the last days of August the offices and research collections were transferred from the temporary quarters at 343 Sansome Street to the new Museum building. The Sansome Street quarters were given up and the rent ceased August 31, 1915.

Construction work on the three exhibition halls continued with reasonable speed. The connecting corridor was completed early in September and the installation of the Fitzhugh-Lowe collection of Indian baskets, pottery and stone implements was begun at once and completed in December. This collection consists of a total of about 15,000 specimens, of which practically all except duplicates have been placed on exhibition. The space available for this exhibit has been completely utilized; indeed, the objects now on display are in many cases too crowded for the best effect. Considerable additional space will be needed if the entire collection is to be properly exhibited.

The Academy is indebted to the public spiritedness and generosity of Hon. Wm. M. Fitzhugh for the opportunity to put this splendid collection on exhibiton.

The California Mammal Hall and the Bird Hall were completed in December and the installation of the habitat groups was at once begun. Considerable progress has already been made.

ELK DISTRIBUTION

In the fall of 1914 the Academy, with the coöperation of Messrs. Miller and Lux and the Southern Pacific and Santa Fé railroads, undertook to distribute a portion of the Kern County herd of elk to suitable reservations in the State. A total of 54 animals were distributed, as set forth in detail in the Director's report for 1914. In the fall of 1915 this conservation work was again taken up. Messrs. Miller and Lux again built a large corral on their alfalfa land near Buttonwillow, in which they succeeded in trapping about 100 elk, mostly females and young, of which 92 were distributed by the Academy in November and December, as follows:

Thomas Jacob, Visalia, for Mooney Park, near Visalia, 1 male and 3 females.

W. C. Claybaugh, for Fresno City Park, 1 female.

A. V. Lisenby, Fresno, for large reservation near Friant, 1 male and 2 females.

P. H. Loinaz, Fresno, for private park near Fresno, 1 male and 1 female.

John Zapp, Fresno, for private park near Fresno, 1 male.

Walter L. Chrisman, San Jose, for Alum Rock Park, 2 males and 2 females.

A. T. Hain, Cook, California, for Vancouver Pinnacles Reservation, 1 male and 3 females.

J. F. Dunne, Gilroy, for a 15,000-acre reservation near San Felipe, 1 male and 4 females.

P. C. Morrissey, Santa Cruz, for Laveaga Park, Santa Cruz, 2 males and 4 females.

H. L. Middleton, Boulder Creek, for the California Redwood Park, 4 females.

Park Commissioners, Sacramento, for Del Paso Park, 3 males and 9 females.

Park Commissioners, Petaluma, for City Park, 2 males and 10 females.

Henry D. Nichols, San Francisco, for large reservation at Eden Valley, near Willits, Mendocino County, 2 males and 10 females.

Park Commissioners, San Diego, for Balboa Park, 3 males and 19 females.

Some of these shipments are regarded as experimental. It is not certain that the elk will do well in all the places to which they were sent. This is particularly true of the northern shipments to Sacramento, Petaluma, and Mendocino County, although reports received from Sacramento and Petaluma state that their elk are doing well. A report recently received regarding the Mendocino shipment is not so favorable. Nine of the 12 have died. The winter there has been unusually severe, with unprecedentedly heavy snow. It is believed that the climatic conditions in that part of the State are too severe for this species, whose natural habitat is further south in a milder climate.

The reports regarding the shipments of 1914 are uniformly favorable. They indicate that the elk are doing well in all places. The animals have grown markedly, several fawns have been born, and all are in good condition.

It is hoped and believed that these transplantings will aid materially in preventing the extinction of this interesting species of big game.

DEPARTMENT ACTIVITIES

Owing to the demands of building, moving and installation, the activities of the respective departments were necessarily greatly restricted. Getting the collections ready for transfer, then the actual moving, followed by the installation in the new quarters, engaged the curators and their assistants during the larger part of the year. Nevertheless each department was able to accomplish considerable additional work of importance.

1. *Department of Herpetology.*—The assistant curator spent several weeks engaged in field work in southern California which resulted in considerable additions to the collections. During the year the total number of specimens in this department was increased from 31,470 to 32,280. Among the additions is a specimen of the very rare species of gigantic land tortoise of Aldabra.

In spite of the work and confusion incident to moving, the regular routine work of caring for the collections has progressed, and much has been done in the way of classification, labeling, arranging, and card cataloguing.

A paper dealing with the amphibians and reptiles of Utah was completed by the department and published in June. Other scientific papers based on the collections are in course of preparation. A vivarium has been constructed on the roof of the rear exhibition wing in which various species of reptiles and amphibians are kept for observational purposes.

2. *Department of Entomology.*—No successor as assistant curator has as yet been appointed to the late Mr. Charles Fuchs, and the department has therefore been without the services of a preparator. The collections have been inspected from time to time, and they have been enriched by a number of considerable donations, as listed in the appendix to this report.

Certain series of specimens have been assigned to specialists for study and report.

The proper building up and care of the collections in this department require the employment of additional help and it is hoped this can be done.

3. *Department of Ornithology.*—The very large and valuable collection of birds is now installed in suitable cases in the new building. No field work was done by the department in the year, and, as a consequence, only a few minor additions to the collections have been made. Mr. Loomis has made constant use of the Tubinares of the collection in connection with the preparation of a monograph on that group of birds upon which he is engaged.

4. *Department of Mammalogy.*—The acting curator and his assistants during the year gave practically all their time to the preparation of materials for the habitat groups which are now being installed. No field collecting was done except incidental to other work. Some specimens, however, were obtained, especially in connection with the moving of the elk.

5. *Department of Invertebrate Zoology.*—This department was reëstablished only a year ago, and only a small allotment was made for its use. This fund has been expended in part in starting the making of a synoptical series of the marine invertebrates of the California coast.

6. *Department of Invertebrate Paleontology.*—Mr. F. M. Anderson, the curator of this department, was absent on leave during the year, engaged on certain special work for a large

oil company in Colombia, South America. Under the immediate direction of the assistant curator, the department has been active in building up and caring for the collections, and in carrying on research work. The months of April to June were chiefly devoted to packing the collections preparatory to moving. During August and September the collections were moved, unpacked, and installed in the cases in the new building. Although these duties required a great deal of time, opportunity was found to do some field work. Two trips were made to the Petaluma Quadrangle, which resulted in clearing up a number of the problems concerning the geologic history of that region.

During the year the Academy published a paper prepared by the assistant curator dealing with the Fauna of the Type Tejon, and its relation to the Cowlitz phase of the Tejon group.

The Academy also published a paper by Dr. E. T. Dumble, based partly on Academy material, on the Tertiary deposits of Northeastern Mexico. Three other papers based in part on the collection of this department have been completed and accepted for publication, and at least two others are in preparation.

Many and valuable additions to the collections of this department during the year, most of them being donations by various exhibitors at the Panama-Pacific International Exposition. These are set forth in detail in the appendix to this report. Mr. F. M. Anderson and Mr. Bruce Martin made extensive collections at Gatun, on the Panama Canal, and on the north coast of the United States of Colombia. These collections include both recent and fossil shells and constitute a valuable addition to the department's research materials.

Professor Yabe of the Imperial University of Tokyo has already given the Academy an excellent collection of Pleistocene and a few Cretaceous fossils from Japan, and an exchange of other specimens has been arranged.

Arrangements have been made whereby the California State Mining Bureau will instal in the Museum a comprehensive exhibit illustrative of the mineral resources of the state. The Standard Oil Company has offered to instal an exhibit of models, charts, etc., that will, it is believed, prove of great edu-

cational value in elucidating a number of the more important and popular phases of the oil industry.

7. *Department of Botany.*—The usual activity has been displayed by the curator in caring for the herbarium and securing accessions to it. During the year there have been added to the herbarium 2220 mounted sheets representing 1241 species new to the collection. The herbarium now contains a total of 20,586 mounted sheets representing 7997 species, all properly arranged in the herbarium cases. Besides these there is a large number of specimens not yet mounted. There are also 475 fungi types in envelopes arranged alphabetically in boxes. These were saved from the fire of 1906. Besides these there are 1136 specimens of phanerogams containing 711 types and 96 cotypes saved from the fire. Besides these, certain other specimens were saved from the fire because of the fortunate circumstance that they were loaned at the time. They are as follows: A large bundle of Giiias returned from Germany, and containing many types; a bundle of *Ptelea* returned from Washington; some specimens of *Eschscholtzia* which had been loaned to the late Dr. Edward L. Greene; and most of the Academy's specimens of *Lupinus* and some of *Delphinium* which had been loaned to the Gray Herbarium, all of which have been returned. All these specimens saved from the fire fill one herbarium case in which they are now installed.

Owing to the inexcusable failure of the author of the reports on the Galapagos plant collections to correlate properly his published identifications with the specimens, the curator has found it necessary to go over the entire collection and identify each specimen anew. This has entailed a vast amount of work.

Within the year the curator made a number of brief collecting trips, as follows: One to the region of the San Antonio and Nacimiento rivers near Jolon in Monterey County, and to Aromas in San Benito County; one to Mt. Diablo; one to Mt. St. Helena, Calistoga, and the Petrified Forest; one of a week's duration in the foothills of Mariposa County; one to Bodega Point, the type locality of many species; and finally, a brief trip to Los Angeles and San Diego. All these trips were brief and were

made at very little expense, the total amounting only to about $70.00.

Mention should be made of the valuable voluntary service which Mrs. Marian L. Campbell, Mrs. G. Earle Kelly and Mrs. Elizabeth Parsons Hawver have rendered the Academy. Mrs. Campbell has mounted 6434 sheets of herbarium specimens. Mrs. Kelly has mounted 218 sheets of specimens from the Grand Canyon. And Mrs. Hawver has put the collection of ferns in order. The fern collection contains a great many exotic genera and species, some donated by the Philippine Bureau of Science, some donated by Doctors Fred and Charlotte Baker, and a fine collection of 100 Hawaiian ferns donated by Mrs. Zelia Nuttall.

The curator has continued her excellent work with the Botanical Club and with the Park gardeners. The Botanical Club holds weekly meetings at the Academy or in the field. The Gardeners' class also meets once a week at the Park Lodge.

8. *Department of Exhibits.*—This department has been busy during the year preparing the large habitat groups of mammals and birds which are now being installed. One of the assistants was detailed for a considerable portion of the year to duties in connection with the building operations and, later, for a few weeks in connection with the elk distribution.

The installation of the large habitat groups has begun. The Antelope, Mule Deer (winter scene), and Steller's Sea Lion groups are nearing completion. The backgrounds are practically done, the animals are in place, and the accessories will soon be finished. Work has begun on the California Sea Lion and the Farallon Bird groups, and it is hoped they may be completed within the next two months. Then the Leopard Seal, the California Valley Elk, the Desert Mountain Sheep, the Mountain Lion, the Black Bear, and the Los Baños Bird groups are all ready as to materials, and the Desert Bird group is ready except as to a part of the accessories.

It is intended to place in the Mammal Hall six additional groups, viz: the Buro Deer, the White-tail Deer (fall scene), Humboldt Elk, Fur Seal, Coyote and Wild Cat, but the materials for these have not yet been collected. The animals for an Elephant Seal group are ready, but there is no suitable place in which to install the group. The same is true of the Win-

ter, Spring, Summer and Fall groups of the Black-tailed Deer. The animals and accessories are all ready, but there is no suitable place in which to place them. The animals are also on hand for two Gigantic Land Tortoise groups, but the accessories have not been prepared and there is no suitable place for the groups unless two of the spaces in the Bird Hall be utilized for that purpose.

The present situation regarding the habitat groups is therefore as follows:

a. Groups for which practically all animals and accessories are prepared and which will be completed within the next few months: Steller's Sea Lion, California Sea Lion, Leopard Seal, Antelope, Mule Deer (winter scene), California Valley Elk, Desert Mountain Sheep, Mountain Lion, Black Bear, Farallon Bird group, and Los Baños Bird group.

b. Groups for which all the animals and accessories have been prepared but for which there is no suitable place in which to install them: Four seasonal groups of the Black-tailed Deer.

c. Groups for which the animals but not the accessories have been prepared, but for which there is no suitable place for installation: Elephant Seal group.

d. Groups for which most of the animals and accessories have been prepared and which with a little more collecting can be installed: Desert Bird group.

e. Groups for which the animals are on hand and some of them mounted, for which the accessories are needed and for which there is no suitable place for installation unless space in the Bird Hall be used: Two Gigantic Land Tortoise groups.

f. Groups for which suitable places for installation have been provided but for which the animals have not been collected nor the accessories prepared: Buro Deer, White-tailed Deer, Humboldt Eik, Alaska Fur Seal, Coyote, and Wild Cat.

It is the intention to endeavor to collect this spring and next fall the animals required for the Alaska Fur Seal, the

Humboldt Elk, the Buro Deer, and the needed accessories for the Desert Bird groups.

It is also intended to begin the preparation of groups of small mammals and birds to go in the small spaces back of the large panels at the ends of the large groups. There are spaces for 34 of these small groups, 22 in the Mammal Hall and 12 in the Bird Hall. The animals are on hand for only one of these groups (the California Striped Skunk), but it is hoped that materials for several others may be obtained within the year. It is also desired to begin the preparation of small portable groups or exhibits suitable for loan to the schools. These will include not only groups of small mammals and birds, but of other animals and of plants, minerals, etc. It is hoped to make this one of the prominent activities of the Museum.

Exhibit at the Panama-Pacific International Exposition.—When the contracts were let for the Museum it was hoped that the building would be completed by the beginning of 1915 and that a number of habitat groups and other exhibits could be installed early in the year. In view of these probabilities it was decided not to make any exhibit at the Exposition, but to endeavor to have the Museum far enough along to attract a fair proportion of the Exposition visitors. Owing to unexpected delay in building operations this hope was not realized.

The California State Fish and Game Commission desired to make an exhibit at the Exposition, but did not possess suitable materials. Coöperation between the Commission and the Academy was suggested, with the result that an agreement was entered into whereby the Academy would furnish and install the materials and the Commission would meet the expense. This arrangement was carried out and a joint exhibit was installed in the Food Products Palace. The exhibit consisted of the following: A Desert Mountain Sheep group, a Summer Deer group, a Mountain Lion den, a Black Bear den, a hunter's camp, an aquarium, and various minor exhibits. This was completed early in the summer and proved to be one of the most interesting and attractive exhibits of the entire Exposition. There was seldom an hour during the continuance of the Exposition that a large number of visitors could not be seen admiring the various units of this exhibit, and many expressions of approval and appreciation were heard.

ACCESSIONS TO THE MUSEUM

The accessions to the Museum during the year have been many and varied, as shown by the detailed list in the appendix to this report. Most of the accessions have been donations received from exhibitors at the Panama-Pacific International Exposition, among whom may be here mentioned the following: The governments of Argentina, Australia, Bolivia, China, Cuba, Guatemala, Denmark, Honduras, Japan, New Zealand, Norway, the Netherlands, Porto Rico, and Sweden. Important donations have also been received from the following: The U. S. Bureau of Fisheries, the U. S. Geological Survey, the states of Idaho, Montana, Washington, Oregon, Missouri, Louisiana, and New York; also from the Standard Oil Company, the Sacramento Valley Counties Association, the San Joaquin Valley Counties Association, and the Anaconda Copper Company. Considerable donations of cases, matting and other articles have been received from the Exposition Board.

LIBRARY

About 3000 linear feet of metal book stacks have been installed in the library, which occupies rooms on both floors at the south end of the research wing—a room with 846 square feet of floor space on the second floor and one with 1344 square feet of floor space on the first floor, or a total of 2190 square feet.

The books are now being arranged on the shelves according to the Library of Congress Classification, and a good start has been made with the accession list.

RECOMMENDATIONS

Addition to the Museum Building.—It is already evident that the present museum building is wholly inadequate for housing the collections and exhibits of the Academy already on hand. For example, there is no place for the following habitat groups already prepared: Elephant Seal group and the four seasonal groups of the Black-tailed Deer. There is no suitable space for the two groups of Gigantic Land Tortoises and the Iguana, for which we already have the materials, nor for

the 86-foot Sulphur-bottom Whale skeleton. Nor is there any room for suitably displaying any of the many large and very interesting collections of minerals, ores, woods, and other objects received from the Exposition; we have not even storage room for many of the exhibition cases, tables, etc., received from the Exposition.

In order to relieve this congestion, to avoid the necessity of placing exhibits in halls in which they do not logically belong, and to enable the museum to place on exhibition habitat groups and other exhibits already prepared or available for preparation, an additional hall is immediately necessary. Perhaps the most practical and economical thing to do would be to glass over and close in the court between the two rear wings. According to estimates gotten a year ago, this could be done for about $9000.00. It would doubtless cost more now owing to the increased cost of materials. To close in the court and provide a second floor or balcony which would greatly increase the exhibiton space, provide the necessary cases, etc., would now probably require a total of about $20,000.

An alternative would be the construction of a hall across the rear corresponding to the Mammal Hall. This addition would have the same dimensions as the Mammal Hall, but should be very different in internal structure. Its cost would probably not exceed $40,000.

Taxidermists' Shop.—Until recently the taxidermists have used a building of Mr. Rowley's in Berkeley as a taxidermists' shop, for which the Academy paid $300 a year rent. Now that we have moved into the new museum building, it is necessary to have a work shop nearer at hand. A building is needed in which to store the animals, etc., which have not yet been prepared and to carry on all the preparatory work of the Department of Exhibits. It is estimated that such a building as is required, together with proper equipment, could be built for $1500. It would be located in the rear of the present building at a place acceptable to the Park Superintendent.

Exhibits.—It is highly desirable that the habitat groups in the two exhibition halls be put in place at an early date. The large habitat groups for which space has been provided should be installed as rapidly as possible. The same should be done with the small habitat groups of mammals and birds.

The preparation of small portable educational groups should be commenced and proceeded with as rapidly as the materials can be collected. Exhibits in other departments, as botany, entomology, herpetology, paleontology, geology, etc., should soon receive attention. Exhibits should not be limited to the departments of birds, mammals, and anthropology.

Research Collections.—Although the funds of the Academy are quite inadequate to meet its needs, to enable it to do much of that which it would like to do along the various lines of its legitimate activities it is important that none of its essential functions be even temporarily entirely abandoned. While most attention must for the present be given to the exhibition phase of museum equipment, the necessity for the enlargement of the research collections must not be forgotten. These collections should be enlarged by the addition of desirable specimens secured by purchase, exchange, donation and field collecting, and selected to meet the research needs of investigators. The several departments should be productive in scientific investigation and the study material must be provided. Such allotments of funds for field work and the acquiring of specimens should therefore be made as the income of the Academy will justify.

APPENDIX TO THE DIRECTOR'S REPORT

LIST OF ACCESSIONS TO THE MUSEUM, 1915

American Museum of Natural History, New York: Two meadow mice from Alaska; one chipmunk from Three Forks, Colo.; one white-footed mouse from Enterprise, and two meadow mice from Florida; two white-footed mice from Penobscot Co., Maine; two white-footed mice, two chipmunks, and one gopher from Fort Snelling, Minn.; one meadow mouse from Tobique River, and two shrews from Tronser's Lake, New Brunswick; two white-footed mice from Fairview, and one chipmunk from Newton, New Jersey; one pine squirrel from Alder Creek, one from Cornwall, three pine squirrels, one gray squirrel, two musk rats, two white-footed mice, one meadow mouse, one shrew, and one mole from Hastings, one jumping mouse from Lawyersville, one bat and one gray squirrel from New York City, two white-footed mice, two meadow mice, one shrew, and one pine squirrel from Nyack, one woodchuck from Tarrytown Heights, and one cottontail rabbit from West Orange, New York; one meadow mouse from Raleigh, North Carolina; two meadow mice from Rockport, and one from San Antonio, Texas; one meadow mouse from Haitland, and one pine squirrel from Linwood, Vermont; and four musk ox and one Peary caribou, collected by Lieutenant R. E. Peary in North Grant Land. Exchange.

Anaconda Copper Co., through Mr. E. P. Mathewson, Anaconda, Montana: Fifteen specimens of various ores, concentrates, etc.; two specimens of copper; three glass exhibition cases; two circular stands for exhibition; 18 framed photographs and diagrams illustrating smelting, with movable screens for exhibiting diagrams; all from exhibit at the Panama-Pacific International Exposition. Gift.

Anderson, F. M., California Academy of Sciences: Collections of shells, both recent and fossil, made at Gatun, Isthmus of Panama, and on the north coast of the United States of Colombia, with the assistance of Mr. Bruce Martin. Exploration.

Argentine Committee in Buenos Aires, for the Panama-Pacific International Exposition, through the Honorable Enrique M. Nelson, Vice-Commissioner General in Charge: Sixty-nine specimens of Argentine woods, and 86 packages of seeds of various species. Gift.

Arnold Arboretum, Jamaica Plain, Mass.: A collection of 1243 herbarium specimens, including 143 genera, 21 of which are new to the Academy's herbarium, and 730 species. Exchange.

Australia, Government of (New South Wales), through the Honorable Niel Nielson, Commissioner for New South Wales, Panama-Pacific International Exposition: Fourteen cases of ores; one block of bituminous shale; four mounted birds; 24 plaster casts of fishes; one Black-tailed Scrub Wallaby (*Macropus ualabatus*), mounted; one mounted Wombat (*Phascolomys mitchelli*); and seven large photographs of natural scenery. Gift.

Australia, Government of (Queensland), through the Australian Commission, Panama-Pacific International Exposition: Ten specimens of native woods. Gift.

Baker, Dr. Fred and Dr. Charlotte, San Diego, Cal.: A collection of more than 1000 specimens of plants from Japan and the East Indies, consisting of 277 genera, and 498 species, and including one family, 65 genera, and 412 species that are new to the herbarium of the Academy. Gift.

Barbour, Thomas, Cambridge, Mass.: One lizard from Cuba. Exchange.

Blumer, J. C.: Four specimens of plants from Arizona. Gift.

Bolton, A. L., California Academy of Sciences: One badger skull from Arizona. Exploration.

Bolton, A. L., California Academy of Sciences: A collection of plants from the Mohave Desert and Arizona, including about 40 species. Gift.

Bowman, Miss Agnes, San Francisco: Fifteen specimens of plants from the Grand Canyon of the Colorado. Gift.

Breeze, Wm. F., San Francisco: A series of insects. Gift.

British Museum, London: One hundred and fifty-five specimens of plants, 32 of which were collected by Dr. Frank in Ohio in 1835, and 123 by Leo Lesquereux. Exchange.

Buttle, Mrs. Alvina, San Diego, Cal.: Sixteen specimens of plants from San Diego Co., Cal. Gift.

California Fish and Game Commission, San Francisco: A set of quail's eggs. Gift.

California, State of, through Mr. W. D. Egilbert, Commissioner General, Panama-Pacific International Exposition: Sixteen plate glass show cases with stands, and two large safes. An indefinite loan.

Carlson, John I., California Academy of Sciences: One snake and eight lizards from Cochise Co., and one toad from Yuma Co., Arizona; two snakes, one lizard and one salamander from San Francisco, and five lizards, one tree toad, and two salamanders from Santa Catalina Island, Cal.; 12 lizards from El Paso Co., and seven lizards from Fort Bliss, Texas. Exploration.

Carlson, John I., California Academy of Sciences: A collection of 184 specimens of plants from Arizona; 54 from Santa Catalina Island, Cal.; and 74 from Texas; many of the species being new to the herbarium of the Academy. Exploration.

China, Government of, through the Honorable Chen Chi, Commissioner General, Panama-Pacific International Exposition: Eighty-eight specimens of woods; 165 specimens of minerals; 17 boxes of cocoons; three boxes of skeins of silk; specimens of silk worms in alcohol; specimens of 192 varieties of seeds; one pair of buffalo horns; 24 framed photographs of natural scenery; 135 glass jars, bottles, and large containers for exhibition material; and a miscellaneous lot of exhibition boxes, cases, etc. Gift.

Chipman, Dr. E. D., San Francisco: One snake from Fresno Co., Cal. Gift.

Cockerell, T. D. A., State University of Colorado, Boulder, Colo.: One bundle of specimens of plants from New Mexico. Gift.

Combined Amusements Co., Panama-Pacific International Exposition, through Mrs. Nellie Waterhouse Dorne, San Francisco: Two anhingas and one manatee from Florida. Gift.

Coombs, Mrs. A. L., San Francisco: Seventy-four specimens of plants from Oregon. Gift.

Cuba, Government of, through General E. Loynaz del Castillo, Commissioner General for Cuba, Panama-Pacific International Exposition: Section of a Cuban Fan Palm (*Calpothrinax wrightii*); eight specimens of ores; one specimen of serpentine rock; and a specimen of asphalt. Gift.

Dickerson, Dr. Roy E., California Academy of Sciences: Two snakes from San Francisco. Gift.

Dorne, Mrs. Nellie Waterhouse, San Francisco: Specimen of a fossil tree from Arizona. Gift.

Eastwood, Miss Alice, California Academy of Sciences: Two hundred and four specimens of plants from Bodega Point, Sonoma Co.; 16 specimens from Granada, and 225 from vicinity of King City, Monterey Co.; 20 specimens from Lagunitas, Marin Co.; 208 specimens from Mariposa and Merced counties; 123 specimens from Mount Diablo; 148 specimens from Mount St. Helena; 33 specimens from Point Reyes and Inverness; and 20 from San Leandro, Alameda Co.; 191 specimens of California grasses; 621 specimens of exotics cultivated in California; and 1110 mounted specimens from the Yukon-Alaska expedition. Exploration.

Edmands, W. H., Lake, Cal.: One woodpecker, one screech owl, and two least bitterns. Gift.

Evermann, Dr. Barton W., California Academy of Sciences: One snake and two lizards from Kern Co., Cal. Gift.

Evermann, Dr. Barton W., California Academy of Sciences: Seventy-three specimens of plants from Kern Co., Cal. Gift.

Farrell, Miss Margaret, San Francisco: Six specimens of Oregon woods from the "White Pine Home" at the Panama-Pacific International Exposition. Gift.

Fauntleroy, Miss Sophie, Santa Barbara, Cal.: Fifteen specimens of plants from Mariposa Co., Cal. Gift.

Gerrard, Edward, & Sons, London: Seventeen snakes from India; four turtles from Borneo; one tortoise from Madagascar; one lizard from New Zealand; and one tortoise from the Seychelles Islands, Africa. Exchange.

Gester, Clark, San Francisco: A series of tertiary shells from Peru. Gift.

Gray Herbarium, Cambridge, Mass.: A collection of 501 specimens of plants from Washington, Utah, and the eastern United States, and from Mexico, Philippine Islands, and Siberia. Exchange.

Guatemala, Government of, through the Honorable José Flamenco, Commissioner General, Panama-Pacific International Exposition: Nineteen specimens of minerals; 19 specimens of native woods; specimens of fibre, cotton, wax, rubber, etc. Gift.

Halton, Miss Harriet, Carmel, Cal.: Nine specimens of plants from Monterey, Cal. Gift.

Henry, Prof. J. K., Vancouver, B. C.: A collection of plants from Vancouver, B. C., comprising about 120 specimens. Gift.

Herring, J. P., California Academy of Sciences: Five jack rabbits, 13 white-footed mice, two coyotes, two southern California elk, and two elk skulls, from Buttonwillow, Kern Co.; three wood rats, four tree squirrels, one weasel, one shrew, two ground squirrels, 10 chipmunks, one mole, seven meadow mice, and one bat, from Mendocino Co., Cal. Exploration.

Honduras, Government of, through the Honorable Timoseo Miraldo, Commissioner General, Panama-Pacific International Exposition: Thirty-four exhibition jars and bottles; 34 specimens of native woods; specimens of seeds, jasper, iron ore, etc. Gift.

Hubbs, Carl T., Stanford University, Cal.: A collection of marine invertebrates from Pacific Grove, Cal. Exploration.

Hurter, Julius, St. Louis, Mo.: Two turtles from Bayou La Battre, and one turtle from Mount Vernon, Alabama; one toad from Yavapai Co., Arizona; one lizard from Santa Catalina Island, Cal.; two lizards and one turtle from British Honduras; and two lizards and one turtle from Guatemala. Exchange.

Idaho, State of, through the Idaho State Commission, Panama-Pacific International Exposition: Twenty-five specimens of ores; one specimen of Yew. Gift.

Imperial University of Japan, Tokyo: A collection of Pleistocene, and a few Cretaceous, fossils, from Japan. Exchange.

Japan, Government of, through the Honorable H. Yamawaki, His Imperial Japanese Majesty's Commissioner General to the Panama-Pacific International Exposition: Thirty-one sections of native bamboo; specimens of zinc ores; a quantity of zinc dust; four large water-color paintings representing the four seasons; and two glass show cases. Gift.

Kaeding, Mrs. Mary C., San Francisco: One fish duck, one hoopie, and two kingfishers from Korea. Gift.

Kusche, J. Aug., Eldridge, Cal.: A collection of forty-one specimens of plants from Alaska. Gift.

Lehman, Mrs., White Pass, Alaska: Six botanical specimens from Alaska. Gift.

Mailliard, Joseph, San Francisco: Two topotypes of the Kern Redwing (*Agelaius phœniceus aciculatus*) from Kern Co., Cal. Gift.

Martin, Bruce, Cartagena, Colombia, S. A.: A collection of insects from the United States of Colombia, S. A. Gift.

McAllister, M. Hall, San Francisco: Three young Golden Beavers (*Castor subauratus*), taken in the Suisun marshes, Cal. Gift.

McAtee, W. L., Washington, D. C.: Seventeen specimens of plants from Washington, D. C. Gift.

McClellan, J. Ellis, Fort Worth, Texas: One lizard from Fort Worth, Texas; and one lizard from Juarez, Mexico. Gift.

McDonald, Miss Julia, San Francisco: A collection of plants from Fresno Co., Cal., comprising about 90 specimens. Gift.

McGuire, Ignatius W., California Academy of Sciences: One snake from Marin Co., Cal. Gift.

Meiere, Mrs. Ernest, San Francisco: Three specimens of plants from northern California. Gift.

Milvain, Miss Margaret, Dawson, Yukon: Thirteen botanical specimens from Alaska. Gift.

Missouri, State of, through the Commissioner General, Missouri State Commission, Panama-Pacific International Exposition: Twenty-six specimens of minerals; one cotton plant. Gift.

Murphy, R. C., Brooklyn Museum, Brooklyn, N. Y.: Two lizards from Mexicali, Lower California. Gift.

New York, State of, through Mr. Daniel L. Ryan, Secretary, New York State Commission, Panama-Pacific International Exposition: Thirteen exhibits of garnet powders and sands, and three specimens of minerals. Gift.

New Zealand, Government of, through the Honorable E. Clifton, Commissioner General, Panama-Pacific International Exposition: One lizard (*Sphenodon punctatus*), from New Zealand. Gift.

Norway, Government of, through the Honorable Consul F. Herman Gade, Commissioner, Panama-Pacific International Exposition: Two cases containing exhibits of paper making, and two tables. Gift.

Oregon, State of, through the Honorable Oscar E. Freytag, Oregon State Commission, Panama-Pacific International Exposition: Twelve specimens of various Oregon woods. Gift.

Pack, Herbert, Salt Lake City, Utah: Eleven snakes from Morgan Co., eight frogs from Cache Co., and eight frogs and two salamanders from Salt Lake Co., Utah. Gift.

Phelps, Mrs. Kate Eastwood, Denver, Colo.: A collection of ninety-five specimens of plants from Colorado. Gift.

Porto Rico, Government of, through the Honorable Martin Tranèso, Jr., Acting Governor of Porto Rico, and Mr. E. T. Hull, Manager Porto Rico Coffee Exhibit, Panama-Pacific International Exposition: A relief map of Porto Rico; nine framed photographs of Porto Rican natural scenery; and one wooden coffee mill and pestle. An indefinite loan.

Rixford, G. P., San Francisco: Twenty specimens of plants from various localities in California. Gift.

Rothschild, Hon. Walter, Thring, England: One fossil turtle carapace from Madagascar; one tortoise cast, Rotumah Islands; two tortoise casts, Seychelles Islands, Africa; and three casts of carapaces, and two tortoise casts, localities unknown. Exchange.

Rowley, John, California Academy of Sciences: Five Steller's sea lions from Año Nuevo Islands; and striped skunk for group, from Monterey, Cal. Exploration.

Rowley, John, California Academy of Sciences: Three roadrunners, one flicker, two red-tailed hawks, and one ferruginous rough-legged hawk, from Kern Co., two mountain quails and one fox sparrow from Mendocino Co., Cal. Exploration.

Ruddock, Geo. T., San Francisco: Twelve specimens of plants from Arizona. Gift.

Sacramento Valley Counties Association, through the Sacramento Valley Commission, Panama-Pacific International Exposition: Forty-four specimens of minerals. Gift.

San Joaquin Valley Counties Association, through Mr. Walter C. Maloy, Assistant Manager San Joaquin Valley Exhibit, Panama-Pacific International Exposition: Three hundred and six specimens of minerals, gold, silver, lead, zinc, copper, and iron ores, flint, asbestos, etc.; specimens of box woods; 57 specimens of various California woods; five specimens of petrified wood. Gift.

Seitz, Mrs. A. R., Beaumont, Cal.: Seven specimens of plants from Riverside Co., Cal. Gift.

Simson, Leslie: Two moose, three caribou, three mountain goats, three mountain sheep, and four brown bears from Alaska. Purchase.

Sisson, L. H.: One weasel from Alturas, Cal. Gift.

Slevin, J. R., California Academy of Sciences: Six snakes, 20 lizards, 11 toads, 119 tree toads, 14 frogs, and two salamanders from Los Angeles Co.; 70 snakes, 175 lizards, six toads, one tree toad, five frogs, and two turtles from San Diego Co.; and one lizard from Lower California. Exploration.

Smith, L. E., Sisson, Cal.: A collection of specimens of plants from northern California, comprising about 130 specimens. Gift.

South Dakota, State of, through Mr. Charles McCaffree, Commissioner of Immigration: Six specimens of ores from the Homestake Mine, from exhibit at the Panama-Pacific International Exposition. Gift.

Sperry Flour Co., San Francisco, through Mr. B. D. Ingalls, Manager Sperry Exhibit, Panama-Pacific International Exposition: Four millstones. Gift.

Standard Oil Co., San Francisco: A relief map of California showing oil fields; two panoramas in oil tanks illustrating the drawing and refining of oil; diagram of section of an oil field showing oil bearing strata; diagram of section of an oil well; 35 jars of asphalt in block, with four glass models showing materials in block; 11 legends for use in exhibition; and eight diagrams, with stands; all from exhibit at Panama-Pacific International Exposition. Gift.

Stark, Dr. E. T., San Francisco: A series of minute fossils from the Midway Oil Field, California. Gift.

Sweden, Government of, through the Honorable Richard Bernstrom, Commissioner General, Panama-Pacific International Exposition: Three cases of specimens of various minerals; exhibits of sugar products; a quantity of wood acid; and one exhibition glass case and stand. Gift.

U. S. Bureau of Fisheries, through Dr. Hugh M. Smith, Commissioner, Washington, D. C. A large *Tridacna gigantea* on stand; eight specimens of American lobster; two glass jars containing fishes; 39 glass vials of embryo fishes; eight swordfish "swords"; plaster cast of the head of a blackfish; one case exhibit of young oysters on net; nine "saws" of sawfishes; four jars containing specimens of lobsters; one fur-seal group and base; two live alligators; 14 live turtles; one live frog; one stuffed alligator; five jawbones of sharks; 10 jars of fish glue; 64 jars of fish oil; five specimens of fossil shells; 15 jars fish products; 20 jars of whale bone and salmon fertilizers; one eel pot; three lobster pots; one skate of halibut trawl; four buoys for halibut; haddock and cod trawls; wicker eel pot; one Pacific Coast trawl line; model of Cail Fishway and stand; bundle of isinglass; three tables; two unit cases; 33 pieces of balene; small angling case complete; and containers for oil and fertilizer; all from exhibit at the Panama-Pacific International Exposition. An indefinite loan.

U. S. Geological Survey, through Dr. George Otis Smith, Director, Washington, D. C.: Twenty-three specimens of minerals; specimens of ores, coal, etc. Gift.

U. S. National Herbarium, Washington, D. C.: Four hundred and eighty-five specimens of plants from Mexico, the species all new to the herbarium of the Academy. Exchange.

Van Denburgh, Dr. John, California Academy of Sciences: Six snakes from El Dorado Co., one lizard from Plumas Co., one lizard from San Mateo Co., four snakes, five lizards, two tree toads, 10 frogs, and 42 salamanders from Santa Clara Co., one snake and six lizards from Tehama Co., Cal.; and four lizards from Washoe Co., Nevada. Exploration.

Van Dyke, Dr. E. C., California Academy of Sciences: A series of insects from Lake Tahoe, California. Exploration.

Washington, State of, through Mr. Charles G. Heifner, Executive Commissioner, Panama-Pacific International Exposition: Eighty-five specimens of various minerals; and two specimens of woods. Gift.

Webb, Miss Zelia, Campo, Cal.: Two snakes from San Diego Co., Cal. Purchase.

Wilkens, Mrs. Johanna E., San Francisco: Seventeen tree toads from San Francisco. Gift.

LIST OF ACCESSIONS TO THE LIBRARY, 1915

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Belding, Lyman, Stockton, Cal.: One hundred and forty-six books and pamphlets, relating chiefly to ornithology, and including many rare numbers of the Academy's early publications. Gift.

Bennett, John E., San Francisco: One pamphlet.

Carnegie Institution, through President Robert S. Woodward, Washington D. C.: A series of 275 volumes forming a nearly complete set of the publications of the Institution to date. Gift.

Commonwealth Club, San Francisco: Twenty bound volumes. Gift.

Davis, Hon. Horace, San Francisco: A complete set of the Academy's publications, all of the earlier volumes finely bound. Gift.

Dickerson, Dr. Roy E., California Academy of Sciences: Two pamphlets. Gift.

Dorne, Mrs. Nellie Waterhouse, San Francisco: Popular Science Monthly, 1915, and three pamphlets. Gift.

Gilbert, Dr. G. K., Washington, D. C.: One copy Geology of the Uinta Mountains, by Powell. Gift.

Guatemala, Government of, through the Honorable José Flamenco, Commissioner General, Panama-Pacific International Exposition: One bound volume. Gift.

Jennings, E. C., New York: One bound volume Fishing Gazette. Gift.

Kaeding, Mrs. Mary C., San Francisco: Two numbers of the Academy's Memoirs. Gift.

Loomis, Leverett Mills, San Francisco: One volume and nine pamphlets. Gift.

Mailliard, Joseph, San Francisco: A set of framed photographs of beavers, taken from life in Stanislaus Co., Cal. Gift.

Mearns, Dr. Edgar A., Washington, D. C.: A series of 48 pamphlets. Gift.

Meek, Mrs. Seth Eugene, Chicago, Ill.: Copy of memorial volume to Dr. Seth Eugene Meek. Gift.

Missouri Bureau of Geology and Mines, through the Missouri Commissioner, Panama-Pacific International Exposition: Twelve volumes, bound in cloth. Gift.

Nichols, J. T., American Museum of Natural History, New York: A complete set of Copeia to date. Gift.

Parker, Sir Gilbert, London: Five bound volumes and many pamphlets, relating to the present war in Europe. Gift.

Parish, Dr. S. B., San Bernardino, Cal.: Nine pamphlets. Gift.

Van Denburgh, Dr. John, California Academy of Sciences: Twenty-seven bound volumes, and three pamphlets. Gift.

Van Dyke, Dr. E. C., California Academy of Sciences: One pamphlet. Gift.

Washington, State of, through the Washington State Commission, Panama-Pacific International Exposition: Fifteen volumes, four U. S. Geological Survey topographic maps, and eight geologic atlases. Gift.

Wilkens, Mrs. Johanna E., San Francisco: Two volumes and four pamphlets. Gift.

Wood, Williard, San Francisco: Eight of the early volumes of the Nautilus, and 18 numbers of the Conchologists' Exchange. Gift.

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